STONE-AGE CHINA | CONODONTS | IMAGES OF HEAVEN AND HELL

ROTUNDA

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2007 spring

THE MAGAZINE OF THE ROYAL ONTARIO MUSEUM

The Research Issue

ROM researchers have dedicated their lives to studies such as searching for evidence of early human ancestors in Paleolithic China, studying puzzling tooth-like ancient fossils in Ontario, and tracking the visual record of belief in the afterlife in Chinese antiquities. Here are three of their stories.

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ROTUNDA

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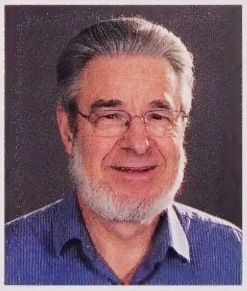
KA BO ("Heaven or Hell") is an art historian specializing in Chinese pictorial arts and calligraphy. She has developed a strong research interest in Chinese culture, textiles, and symbolism. In 2002 she curated the exhibition *More Than Keeping Cool: Chinese Fans and Fan Paintings*, for which she also authored a catalogue with the same title, and in 2004/2005 she curated *Touched by Indigo: Chinese Blue-and-White Textiles and Embroidery*, which also had a catalogue with the same title. *Heaven or Hell: Images of Chinese Buddhist and Daoist Deities and Immortals* is her latest exhibition. In April 2006 she published an article on the ROM's treasured Buddhist wall paintings called "The Paradise of Maitreya: A Yuan Dynasty Mural from Shanxi Province" in *Orientations*, a Hong Kong-based art magazine.



Dr. Peter von Bitter

Department of Natural History

PETER ("Conodont Conundrum") has held many positions during his 37 years at the ROM, from curatorial assistant to senior curator in charge of Paleobiology, to deputy head of the Department of Natural History. He is a professor of geology at the University of Toronto and is presently on a year-long sabbatical. Peter is also Chief Panderer of the Pander Society, an informal worldwide organization of several hundred scientists who work on microfossils called conodonts; he and Joan Burke, the now-retired, long-time departmental assistant in Paleobiology, produce the annual Pander Society Newsletter (see www.conodont.net).

Peter trained during the 1960s at universities in Nova Scotia, Kansas, and Germany before settling at the ROM where he met and married Nancy Gahm, a science teacher in the Museum's Education Department.

Dr. Chen Shen

Department of World Cultures

DR. SHEN ("The Great Thrall of China") is the ROM's Bishop White Curator of Far Eastern Archaeology. Trained in China, the US, and Canada in anthropological archaeology, his expertise is lithic use-wear technique—examination of stone tools under the microscope for evidence of how prehistoric hunter-gatherers made and used tools. He has led the ROM's fieldwork program in paleolithic cultures in northern China since 1997.

ROM MESSAGE

A CHAPTER IS CLOSING in *Rotunda*'s history as a new one opens. Starting with the May 2007 issue, *Rotunda* will be redesigned and reformatted to reflect the new ROM brand. The contemporary styled publication, to be called *ROM* magazine, will continue to run incisive curator-written articles on the ROM's international research programs and renowned collections. And now it will also contain information about what's on at the ROM and the latest donor news within its pages. And, once again, it will be published on a quarterly schedule. Magazines are still available for $5 each or $17 per subscription. Members continue to receive the magazine free with their membership.

Watch your mail mid-May for the inaugural issue of *ROM* magazine. The first edition will be a special souvenir issue celebrating the Michael Lee-Chin Crystal: guest writers will offer analysis of the ROM's Daniel Libeskind-designed addition and the impact it is having on Toronto and Canada as part of a dynamic cultural renaissance. To commemorate the occasion, the souvenir issue will be mailed with more than 100,000 copies of *The Globe and Mail* in addition to its usual circulation.

As we embark on this new journey, we take a fond look back at *Rotunda*'s many former incarnations.

BRIAN BOYLE, ROM / 2006.13.1

COURTESY THE STARK MUSEUM OF ART, TEXAS

Holding the Bag

Paul Kane's 160-year-old treasure

If, for a moment, you place yourself in 1860s Toronto, strolling by the corner of Sherbourne and Queen streets, you would surely admire the Greek Revival-style home, Moss Park, owned by the Honourable George William Allan, former mayor of Toronto. What you would not see, though, is the dim-lit view of Paul Kane shuffling down the front hall toward the library, stopping as he was wont to do to lay his hand on a buffalo robe or breathe in the scent of smoke-tanned skin. This is his collection. Before him are the blankets, rattles, and bags he collected during his three years of travel across Canada, sketching the environment and the peoples he met. Although now melancholy and in declining health, he nevertheless knows that his amble toward the library passes by greatness.

Perhaps in that hallway, and certainly on subsequent walls owned by G. W. Allan's descendants, hung a beaded panel bag that Kane collected in 1846 while he was in the area of Fort Garry, Manitoba. The bag was recently acquired by the ROM in memory of Arthur C. "Tony" Allan thanks to the generous support of the Louise Hawley Stone Charitable Trust and the Friends of the Canadian Collections.

Cree or Cree-Métis in origin, this type of bag was used for carrying personal medicines, flint and steel for fire making, shot for firearms, and tobacco. Its style has considerable antiquity. But in the early 19th century, with new materials introduced through trade, the original style of the bag—made of skin with porcupine-quill embroidery—changed to broadcloth with glass bead designs.

A sketch by Paul Kane now in the Stark Museum of Art in Orange, Texas, shows the 36-year-old artist sitting beside his tent in a field of wild roses. On the ground, just in front of his knee, lies the very same bag. From this sketched image and from its known history as part of the Allan family collection through time until the ROM acquired it, the bag holds collection information that is almost unique for an item of its considerable age. This attribute, combined with the bag's exceptional design, its association with one of the founding fathers of Canadian art, and its story passed through four generations of G. W. Allan's descendants, contributed to the recent decision by the Canadian Cultural Property Review Board to certify the bag as a Canadian National Treasure.

—K. R. Lister

BRIAN BOYLE, ROM / 2005.86.1

Mummy Cover Up

Protecting a priestly afterlife

COFFINS AND MUMMY masks are familiar artifacts in Egyptian galleries around the world, but the ROM's latest ancient Egyptian acquisition is somewhat different. Called a mummy cover, the item would have been placed inside the coffin on top of the wrapped mummy. In use for less than 200 years, mummy covers were made as part of a set together with a coffin lid and bottom. This type of cover was used instead of a more costly mummy mask, and marked the identity of the deceased. Ancient Egyptians believed the spirit could leave the body to visit the places it loved during life. When it returned to the mummified body to rest, both the name on the coffin and the portrait on the mummy cover helped the spirit recognize its body.

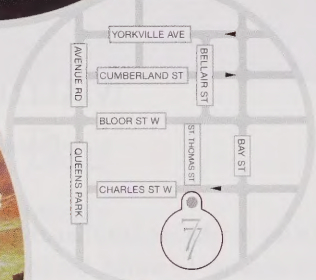
The owner of the ROM's new mummy cover was a chantress of Amun-Re—a singer at temple rituals—as were many women in ancient Thebes. The shemayet or chantresses sang with the rhythm section, clapping and perhaps playing a tambourine. Women of this priestly class ensured that their sons and daughters married the children of other chantresses.

The decorations on the coffin that came with the mummy cover show this woman as a justified spirit, one who has entered into the world of the dead and been accepted by the gods. Sadly, her name is not among the hieroglyphs.

Much as clothing designers do today, ancient Egyptian craftsmen adjusted the colours, shapes, and decoration of funerary wares to suit changing fashions. The yellow background and style of the ROM's mummy cover indicate that it was made sometime between 1045 and 969 BCE. This was a period during which Egypt had lost control of the wealth of Nubia (present-day northern Sudan) and so was much diminished in international power. Since kings and nobles were no longer constructing elegant tombs at Thebes, the artists who worked on them were now available to decorate coffins of the priestly class. Religious images that would once have been carved into tomb walls were now crowded onto the surface decoration of coffins. Prayers and protective images of scarabs and winged goddesses adorned mummy covers.

The ROM's example is typical of its genre. The workmanship of the small scenes is not particularly skilled. But at least one fine artist was at work on it. The elegant face is not so much a portrait as a prayer—that the lady will be young and beautiful again in the next life. This artifact speaks of the human love of beauty and the desire to live on after death across 3000 years of history. It will be on display in the Egyptian Gallery in the future.

—Gayle Gibson



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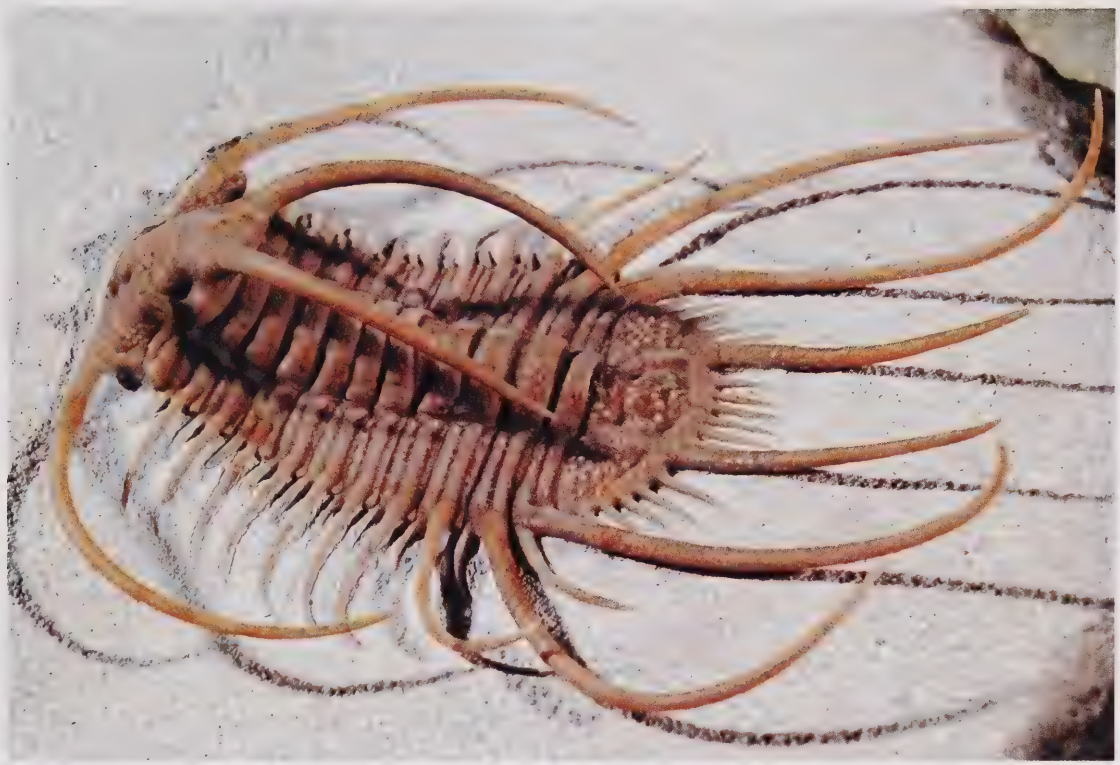
From Russia with Spines

The elaborate eccentricities of fossil trilobite forms.



ROM 57823

DAVE RUDKIN

THE WONDERFUL THING about trilobites, as I have endlessly extolled in previous *Rotunda* articles, is their astonishing diversity of shapes, sizes, and embellishments. If buried and preserved under just the right conditions, the mineralized, multi-piece outer body coverings ("exoskeletons") of these long-extinct sea-dwellers can form fossils of extraordinary complexity, delicacy . . . even beauty.

Through the continuing support of the Louise Hawley Stone Charitable Trust, the ROM's Department of Natural History was recently able to purchase a small selection of trilobite fossils that amply demonstrate the range of exoskeletal flamboyance achieved by these truly ancient mariners. All nine specimens were collected from limestones of Middle Ordovician age (approximately 460 million years old) near St. Petersburg, Russia. Eight are discrete individuals, meticulously excavated from the enclosing matrix so that each trilobite stands in full relief on its sculpted bed of limestone. The ninth is a one-metre-(3¼-foot-) square slab from the same rock formation containing the complete or partial exoskeletons of more than 45 individuals of a single species.

Perhaps the most striking specimen in the lot is the exquisitely and intricately spinose *Boedaspis ensifer*, a delicate jewel of a trilobite that looks as if it could be made of spun sugar. No less spectacular is *Paraceraurus exsul* with pairs of long tapering head and tail spines that arch back in graceful swooping curves. Though less ostentatiously spiny than *Boedaspis* or *Paraceraurus*, *Cybele panderi* is all the more remarkable for having its tiny, calcified compound eyes positioned well above the head shield (cephalon) atop impossibly slender stalks. The functions of such elaborate outgrowths of the exoskeleton are still not fully understood, but their repeated evolutionary appearance in only distantly related

Boedaspis ensifer Whittington & Bohlin, 1958. Length, including spines: 6.5 cm (2 1/2 inches).

ALL PHOTOS BY D. RUDKIN

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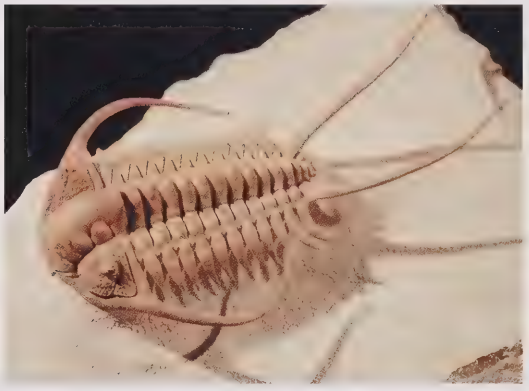

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Top: *Hoplolichoides conicotuberculatus* Nieszkowski, 1859. Length: 6.5 cm (2 1/2 inches) **Bottom left:** *Paraceraurus exsul* Beyrich, 1846. Length, including spines: 15 cm (5 3/4 inches). **Bottom right:** *Cybele panderi* Schmidt, 1907. Length of eyestalk: 1.5 cm (1/2 inch).

trilobite lineages over many tens of millions of years indicates that they probably fulfilled a variety of important roles (see "Paleontological Potpourri" in *Rotunda*, Spring 2005, for examples from the Devonian Period).

Some of the Russian species represented here have been known since the mid-1800s. Much of the Ordovician trilobite material from around St. Petersburg was formally described and named by pioneering Estonian paleontologist Friedrich Schmidt (1832–1908) from 1886 through 1907. It is only within the last decade or so, however, that skilled fossil preparators have developed the techniques and technologies necessary to reveal the exceptionally ornate fossils in their full splendour.

Two other specimens in the ROM's acquisition are particularly noteworthy for unusual exoskeletal features—both are members of a subgroup of trilobites usually characterized by large, flattened, and leaf-shaped tail shields (pygidia), and by an odd pattern of lobes on the cephalon. *Hoplolichoides conicotuberculatus* is so named for the many small cone-shaped bumps, or tubercles, that cover much of the exoskeleton. Aside from being a rather warty looking beast, it also possesses a pair of blade-like spines that diverge backwards from the middle-rear of the cephalon, and two spines that arise from adjacent segments near the back of the thorax (the multi-articulated region between the cephalon and pygidium).

Metopolichas platyrhinus, in contrast, seems positively drab in appearance . . . except for the conspicuous

ROM 57828

ROM 57830

snout-like extension from its triangular cephalon. The Greek roots (*platy* + *rhino*) of its particularly apt species name translate as "flat nose." Exceptional preparation of this splendid specimen reveals that it is flexed slightly upwards, as if the trilobite was about to rear up off the ancient sea floor. The entire underside of the cephalon has been skillfully exposed to show the hypostome—a large calcified plate that covered the mouth area—still in place. One fine example each of *Estoniops*, *Cyrtometopella*, and *Pandaspinapyga* rounds out the array of individual trilobites.

The prize for overall size and sheer numbers, however, goes to a hefty slab bearing multiple individuals of *Xenasaphus devexus*. *Xenasaphus* is a plain-looking trilobite—smooth, rounded, and distinctly unadorned—but lack of exoskeletal extravagance does not appear to have affected its local abundance. This kind of accumulation is interpreted as a "mass mortality," in which many living animals were killed and buried on the sea floor in a singular catastrophic event, such as a storm surge. Mixed with the complete carcasses of "smothered" individuals are disarticulated and fragmentary exoskeletons, suggesting that the event entombed previously moulted or dead and decaying trilobites at the same time.

Top: *Metopolichas platyrhinus* Schmidt, 1907. Length: 10.5 cm (4 inches). **Bottom:** *Xenasaphus devexus* Eichwald, 1840. Length of typical specimen: 12.5 cm (4 3/4 inches).

All specimens from this splendid acquisition will find their way into exhibits in or associated with the planned Renaissance ROM gallery of Earth and Early Life.

Dave Rudkin is assistant curator in the Paleobiology Section of the ROM's Department of Natural History.

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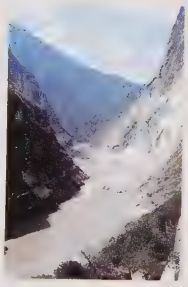

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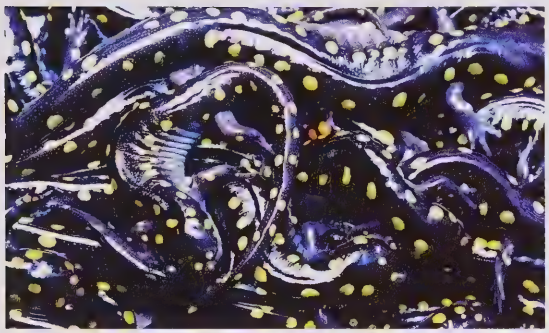
Secretive Salamanders

Lurking under leaf litter and rotting logs in Ontario's woodlands are the most numerous vertebrates in the province.



Clockwise from top left: Spotted salamander (*Ambystoma maculatum*); Northern redback salamander (*Plethodon cinereus*); Jefferson and blue-spotted salamander hybrid (*Ambystoma jeffersonianum, laterale polyploid hybrid*); Eastern or red-spotted newt (*Notophthalmus viridiscens*).

ANDRÉ NGO

Across Ontario, there are more kilograms of living salamanders—if you weighed them all together—than any other vertebrate, including even large animals such as bears and moose. But despite this abundance, you might not readily notice salamanders during a casual walk through the woods. They are rather secretive and nocturnal, moving about after dark and remaining hidden during the day. As amphibians, they need moisture to survive, so to protect themselves, they often hide under leaf litter or rotting logs, and in moist soil, or in the shelter of shadows during warm, dry days, emerging only during the cooler nights when the risk of drying out is far less.

Because of their long slender bodies and tails, salamanders might, at first glance, be confused with lizards. But closer examination reveals significant differences. Salamanders lack the claws, external ear openings, and scales usually seen in lizards. Where these animals do fit into the family tree is in one of three orders of amphibians—the other two being frogs and caecilians, a group of wormlike amphibians. Like other amphibians, salamanders are suited to life both in and out of water. But unlike frogs, they have tails during all phases of their lives. And unlike caecilians, salamanders have four limbs of approximately the same size, set at right angles to the body.

Ontario is host to 11 species of salamander from four different families. Species that might be encountered include the red-spotted newt (*Notophthalmus viridescens*), the red-backed salamander (*Plethodon cinereus*), the spotted salamander (*Ambystoma maculatum*), the Jefferson's salamander (*Ambystoma jeffersonianum*—which is federally and provincially threatened), the blue-spotted salamander (*Ambystoma laterale*), and the small-mouthed salamander (*Ambystoma texanum*—which is endan-

PHOTOS: © R. W. MURPHY

gered federally and provincially).

One often hears salamanders referred to as newts. All newts are salamanders, but not all salamanders are newts. The name "newt" tends to be used for rough-skinned salamanders of the family Salamandridae, including the red-spotted newt (*Notophthalamus viridescens*) found in Ontario. This salamander is especially noticeable as you walk through the woods because of the bright red colour of the juveniles, often called "red efts." These little salamanders are up to 10 times more toxic to predators than the adults, as suggested by their bright colours—a trait often seen in nature and called aposomatic coloration.

The red-spotted newt is remarkable for the rather drastic colour and habit changes it undergoes during its lifespan. After hatching from a jelly-like egg, the tiny smooth greenish salamander larvae, equipped with fluffy external gills and a broad flattened tail to aid in swimming, spend the first part of their lives in water.

As young newts age, their skin roughens in texture and changes from an olive green colour to orange or reddish brown. They also absorb their gills and develop stronger limbs in preparation for the move onto land. The terrestrial stage between the adult and the larval stages can last from two to seven years as the salamander matures. When the newt reaches sexual maturity it does a peculiar thing. It undergoes another extensive physiological change. Its colour changes back to the olive green hue, but this time it develops the characteristic red spots that give the animal its common name. Though gills do not re-form, the skin becomes thinner and smoother again to enable better absorption of oxygen in the water, and the tail flattens, returning the newt to a state much like its larval form. The adult newt then returns to the water.

While these animals are generally aquatic or semi-aquatic as adults, research has shown that, under certain conditions, such as crowding, high temperatures, or a polluted aquatic environment, they can redevelop their juvenile characters and return to a more terrestrial life.

The largest group of salamanders in the province are the mole salamanders, which make up Ontario's bulk of salamander biomass despite the fact that they are rarely seen outside the breeding season. The "mole" appellation comes from the fact that for much of the year these salamanders secrete themselves away underground. During the breeding season, however, these troglodytic denizens of our forests emerge en masse to return to their breeding ponds to mate. Year after year, they crawl from their hiding places and return not only to the same ponds, but usually to the same part of the same pond they frequented in previous years. This is the time people are most likely to see them crawling across roads and culverts.

Lungless salamanders of the family Plethodontidae are aptly named—they really do lack lungs. Like many other amphibians, lungless salamanders are able to absorb oxygen through their skin much as fish absorb oxygen through their gills. To do this, though, they must keep their skin moist by living in damp areas such as springs, streamsides, and forest leaf litter.

Because several of these lungless species require specialized habitats or have a limited distribution, people are not likely to come across them. The tiny eastern redback salamander (*Plethodon cinereus*), however, is relatively plentiful. People are more likely to encounter this species—even under flowerpots in the backyard—though the secretive animal is most often found under decaying logs or in damp leaf litter in the woods.

The fourth and final salamander family found in Ontario is the Proteidae. Only one species represents this family in Ontario: the mudpuppy (*Necturus maculosus*). The Proteidae differs from the other three families by retaining several juvenile characters into adulthood, a phenomenon known as paedomorphosis. Mudpuppies keep the characteristic larval shape, with the rudder-like tail and feathery gills, right through adulthood and do not undergo a terrestrial phase, remaining aquatic throughout their lives. One of the few species of amphibians that are active in winter, these fascinating creatures can be seen moving about under the ice of partially frozen ponds.

Unfortunately, a quarter of Ontario's salamander species are listed as being of special concern, threatened, or endangered—and two species, the tiger salamander (*Ambystoma tigrinum*) and the spring salamander (*Gyrinophilus porphyriticus*) have disappeared from the province entirely. Sadly, the tiger salamander has not been seen in Ontario since 1950.

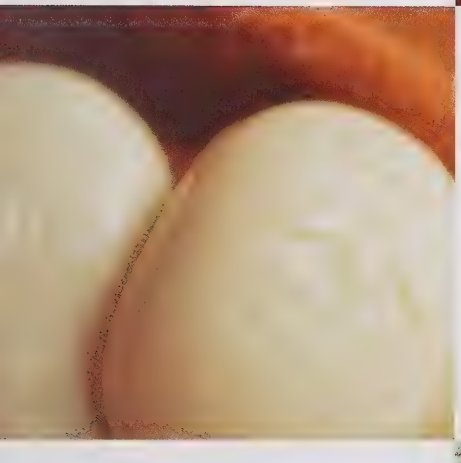
Several local salamander species have entered into self-limiting hybrids—different species interbreed with the unfortunate result that their offspring end up with entire extra sets of chromosomes, and thus extra DNA. This appears to prompt them to show up at breeding ponds later in the season than other individuals. This not only decreases their chances for breeding but also increases the likelihood that the weather will be warmer when they arrive. When the temperature at the time of fertilization is 5°C (41°F) or higher, offspring are more likely to have an even greater number of chromosomes than the parents, which causes them to breed even later. Animals with five sets of chromosomes show up too late to breed at all.

But if you have a careful eye and know where to look, it's still possible to observe many salamanders. The next time you go for a walk in the woods or a stroll by a pond or river keep an eye out for these other Ontario residents as they go about their silent lives all around us.

André Ngo is a PhD candidate in the ROM's Centre for Biodiversity and Conservation Biology.

The drawer pulls –
Antique copper.

The flowers –
Fresh-cut orchids.



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Conodont

For more than 100 years, ancient tooth-like fossi
A ROM scientist's 37-year search to discover h
other questions whose mysteries lie deep in ancie

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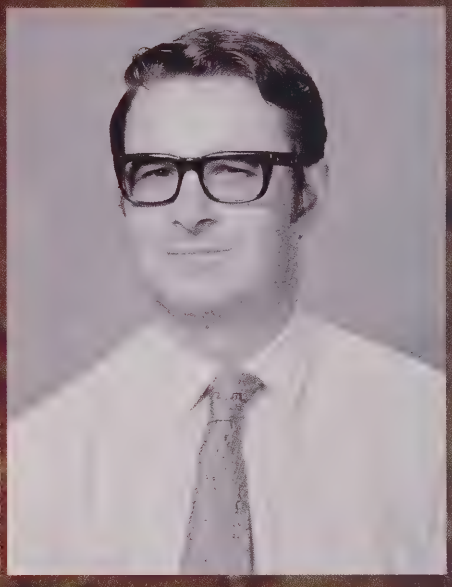


ROM PHOTOGRAPHY

My story is one of being a paleontologist for nearly 40 years at Canada's premier museum, an institution that has allowed me scientifically and intellectually to go where few people have gone before. Research, the search for knowledge and understanding, is a very human activity; thus my story is also one of human interconnectedness and collaboration. It is a story of friendship with farmers and landowners on whose land I have made wonderful new finds, with stonemasons and quarrymen with whom I have discussed the properties of "good" versus "bad" rock, and with scientific colleagues young and old, who have taught me and continually surprised me with new and different points of view. And it is a story of

Conundrum

called conodonts—puzzled paleontologists.
these tooth-like fossils worked and to answer
stone. BY PETER VON BITTER

M.A. HINETZ

ILLUSTRATION BY MARIANNE COLLINS / KATHY DAVID

how research is serendipitous, often depending on chance and opportunity.

My formal journey at the ROM started in 1968 when I wrote to Dr. Desmond Collins, then the new curator of Invertebrate Fossils, inquiring about job opportunities. The ROM was already important in my life. As a high-school student in the late 1950s at Humberside Collegiate in Toronto's west end, I had belonged to the Junior Walker Club, a group of keen mineral-collecting kids that met at the ROM on Saturday mornings and went on field trips together. My high-school friend Paul Hoffman and I not only traded radioactive minerals we had collected near Bancroft with the ROM, but we were on the receiving end of friendly but stern advice

from Dr. Victor Meen, then head of the ROM's Mineralogy Department, that we needed to focus on our studies rather than the perceived shortcomings of adult members of the Walker Club. Since the ROM was already very familiar to me, it seemed natural to ask about work there.

Fortunately, Dr. Collins believed that every well-balanced paleontology department needed someone with my area of specialization. He responded by saying the ROM was indeed looking for a new fossil curator, one who was Canadian, had museum experience, had or was about to get a PhD, and specialized in fossils lacking a backbone, in particular, conodonts. It must have been fate, because those were precisely my qualifications. Two years later, in 1970, after finishing my studies in the US and Germany, I was hired.

You may be wondering what in the world conodonts are. They are tooth-like fossils, mostly smaller than 1 mm (1/25ths of an inch), and made of the same material as our teeth, calcium phosphate. This composition makes them resistant to weathering and they are often preserved where other fossils have been destroyed. For more than 100 years after conodonts were first described in the mid-19th century, there was much debate and little certainty about what kind of organisms bore conodonts and about what conodonts actually did. We now know that numerous different-shaped conodonts combined to form the feeding apparatus in small marine vertebrates. Each kind of conodont had a specialized function, as do our own teeth—serving as deflectors, filters, cutters, and grinders. The small eel-like animals that bore conodonts evolved very rapidly—from about 500 million to 200 million years ago—into thousands of species, before — for reasons we don't understand — they became extinct.

Toronto has a long history in conodont studies. In 1879 George Jennings Hinde, who lived and worked here for most of the 1870s, described 450-million-year-old conodonts from the Garrison Common at Fort York and from the Don Valley. Hinde's was the second major conodont paper published in the world, preceded only by that of Christian Pander of St. Petersburg, Russia, the discoverer of conodonts, who first described them in 1856. Both paleontologists thought that conodonts belonged to a group of fish. We now believe Pander and Hinde were almost correct, Hinde perhaps more so because he was the first to realize that a number of different kinds of conodonts functioned together in the mouth of a "low type" of fish, which he compared most closely to the unsavoury hagfish. The hagfish is the most primitive fish alive today, and like its relative the lamprey eel it lacks both a true jaw and a bony skeleton. Hagfish bore into their prey, and once inside use rasping teeth on their tongues to literally devour their victims from the inside out.

What Pander and Hinde lacked, and indeed science wouldn't have for nearly 150 years, was a complete well-preserved conodont animal. Without that, Pander and Hinde's view that conodont animals were vertebrates was just a theory and not one that was universally accepted. There was more than a century of debate about the biological relationship and function of conodonts. Some scientists agreed with Pander and Hinde and placed conodonts in the vertebrate category (having a backbone), while others classed them as invertebrates (lacking a backbone). A few even regarded conodonts as parts of plants. When I joined the ROM as an invertebrate paleontologist, we conodontologists still lacked even a single exceptionally preserved fossil that could confirm where conodonts belonged.

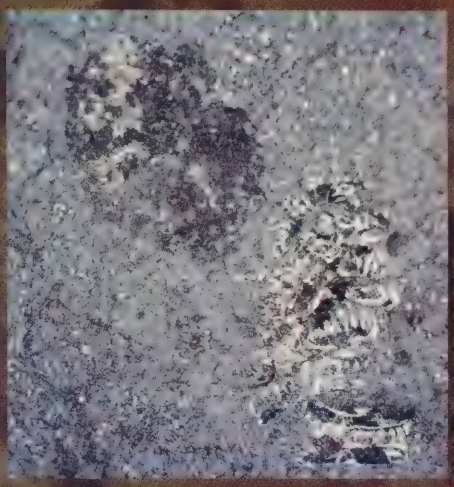
Conodonts are important for a number of reasons. Because they changed shape rapidly over time, they can easily and inexpensively tell us the age of the sedimentary marine rock they are found in—important, for example, when drilling for oil. They are excellent geothermometers, showing us by their colour what temperature their host rock attained while buried at different depths for various lengths of time. When their colour indicates that conodonts were heated to a high temperature, we know that the rocks they are embedded in were likewise heated to the same high temperature, too high for any oil or gas to still be present. Conodonts have been used to reconstruct what ancient seabottoms, which have since split and drifted apart, once looked like. And lastly, now that conodont animals are (again) recognized as vertebrates, they have strengthened the early vertebrate fossil record and stretched it as far back as the Late Cambrian, 500 million years ago.

During my first decade at the ROM as an untenured curator I kept a low profile, doing what any young curator must do—establishing a research program and publishing. I also started a micropaleontology laboratory at the ROM, conducted fieldwork in places such as Atlantic and Arctic Canada and the central US, and began my teaching career at the University of Toronto.

Finally, in the early 1980s, a complete fossil of the conodont animal—the key to conodont biology and function—was at last found. Scottish paleontologist Euan Clarkson, examining some Carboniferous fossil shrimp from Granton, near Edinburgh, which had been ignored in a museum drawer for decades, found one "shrimp" that didn't fit. It possessed a backbone-like notochord, chevron-shaped support structures called myomeres, a tail-like caudal fin, large paired eyes, and a bilaterally symmetrical feeding apparatus made of calcium phosphate by which it ingested and processed food. It turned out that conodont-bearers were not only animals, but they were eel-like vertebrates, and their complex feeding apparatus was composed of different kinds of conodonts. Conodont workers like myself finally had a clue as to what we were working on!

The first conodont animal, *Clydagnathus windsorensis*, has a strong Canadian connection. Long before the complete animal was found in Scotland, Canadian paleontologist Yvon Globensky named the species using only a single type of conodont from Nova Scotia. Also prior to the Scottish discovery, I had collected thousands of conodonts from this species from eastern Canada for the ROM's col-

For more than 100 years after conodonts were first described in the mid-19th century, there was much debate and little certainty about what kind of organisms bore conodonts and about what conodonts actually did.



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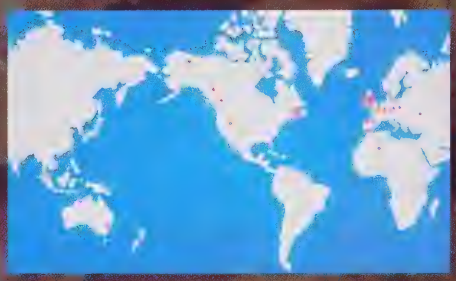
PETER VON BITTER

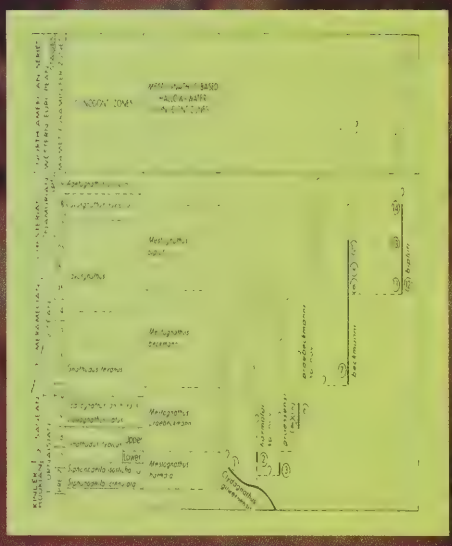


M.A. PURNELL

M.A. PURNELL

PETER VON BITTER

FROM G.J. HINDE, 1879



PETER VON BITTER

Top left: A 430-million-year-old mouth apparatus of *Ozarkodina* with 15 conodonts and preserved eye traces. Hepworth, Ontario. **Bottom left:** Colour alteration in the 330-million-year-old conodont *Mestognathus*. Amber colour means gas and oil is still present; black and white means hydrocarbons are gone. **Top middle:** Some 300-million-year-old conodonts mounted on a microscope slide. Each square is 3.5 mm along the side. **Bottom middle:** Conodonts from Quebec (1-6), Ontario (7-13, 18, 19) and New York (14-17, 20, 21). **Top right:** The scattered, seemingly random distribution of the 330-million-year-old conodont *Mestognathus* in today's world. **Middle right:** The tropical or subtropical distribution of the conodont *Mestognathus*, close to the equator, in the reconstructed world of 330 million years ago. **Bottom right:** The evolution of species of the 330-million-year-old conodont *Mestognathus* used to divide and "tell" time.

lections, reconstructing its feeding apparatus much like one assembles a jigsaw puzzle.

Even though Scotland and New Scotland (Nova Scotia) have drifted apart over millions of years, the connections are still strong. This wasn't evident to me right away, though. After spending a frustrating six-month sabbatical in England and Ireland in the early 1980s trying to find just such connections—the same conodonts on both sides of the Atlantic—I had begun to think that most of the conodonts I had recovered in eastern Canada were restricted to the Canadian side. So I was startled one day in the late 1980s while visiting a colleague in England to see a poster showing 330-million-year-old Carboniferous conodonts from northern England identical to some I had collected in eastern Canada.

Eventually I met Mark Purnell, the graduate student who had found these English conodonts, and a year or two later, about 1990, he came to work with me at the ROM as a post-doctoral fellow. As I was driving him into Toronto after his trans-Atlantic flight, this brand-new 25-year-old PhD turned to me and said: "You know that monograph on east coast conodonts that you published in 1986?"

"Yes."

"Well, you were wrong."

I could have veered off the expressway right then and there, but I kept my eyes on the road and merely replied "Is that so?"

Mark was right, of course, because I had placed the wrong teeth together in my speculation about the feeding apparatus of *Mestognathus*. Mark had a great advantage over me: new conodont collections, a fresh mind, and a certain audacity that the best graduate students have. It didn't take long for him to convince me. For a year or more we worked successfully together on several projects, including advising Rolf Harder, designer of the Canadian conodont postage stamp. Three early Carboniferous conodonts from the ROM collections were illustrated on 3.75 million 40-cent stamps in 1991.

Conodont animals are still very rare, and after Mark returned to England, we began to discuss where additional animals might be found. We decided that our most promising target lay relatively close by, in 430-million-year-old Silurian rocks deposited in what were once quiet tropical lagoons on Ontario's Bruce Peninsula. (These laminated carbonate rocks are quarried extensively and have become popular as facing-stone in architecture, for example, the Isabel Bader Auditorium and the McKinsey & Co. building both on Charles Street in Toronto, just east of the ROM.)

These beds had long been known to contain well-preserved fossil sea scorpions up to 75 cm (about 29 inches) long. More recently, however, smaller fossil animals with preserved soft-body parts, always rare, were discovered. Ancient quiet-water lagoons have often yielded fossils of outstanding quality because as animals died they were quickly buried undisturbed, removing them from oxygen and bacteria, the enemies of preservation.

With help, I started prospecting Ontario's ancient lagoons. The picture that has emerged is of an Ontario "Burgess Shale" of 430-million-year-old animals preserved in unusual ways. At Hepworth, I discovered hundreds of vertebrate mouth apparatuses, each with up to 15 conodonts still arranged as they were 430 million years ago, many of the species also with eyes preserved. This small Ontario community of about 400 people has arguably become the hottest place in the world for finding these still-articulated vertebrate mouth apparatuses, and we are getting ever closer to finding complete animals with soft tissues intact.

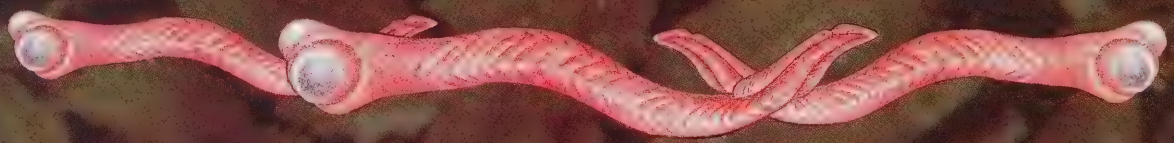
At nearby Park Head, the ancient environment was apparently too near to shore and perhaps too influenced by fresh water for conodont animals to have lived there. But fish lacking true jaws, sea scorpions, polychaete worms, and small bean-shaped arthropods called ostracodes—all organisms that could live in marginally marine environments—are common there. The find of a lifetime was a nearly complete jawless fish found by Christopher Stott, a former student of mine. We christened it the "Thanksgiving Fish" since we collected it on Thanksgiving weekend in 2004. At 430 million years old, this little vertebrate is the oldest complex living thing known from Ontario. It also happens to be very photogenic, being covered with very fine plates that for unknown reasons glow in the dark under ultraviolet light.

One of my favourite examples of the serendipitous, almost accidental, nature of research began in the late 1980s. For two summers, my son, Robert, and I had gone to eastern Canada to collect conodonts from 330-million-year-old Early Carboniferous strata. Near the end of the second summer, in a quiet cove in western Newfoundland, I noticed unusual fossil tubes up to 20 cm (almost 8 inches) long and 3 cm (more than an inch) wide, encrusted with long fingers of carbonate and the brassy-coloured pyrite nicknamed fool's gold. I didn't understand what these tubes were, but I brought several samples back to the ROM for study.

Later that fall, at a lecture in the ROM theatre, University of Toronto geologist Steve Scott showed slides of modern tube-like marine animals with red bushy tops, animals that he had seen first-hand through the windows of *Alvin*, a research submersible, at depths of 2000 metres (6560 feet) in Mexico's Gulf of California. These creatures, which he called tubeworms, are up to a metre (about 3 feet) long and live beside cracks in the ocean floor called hydrothermal vents, which spew sulfurous chemicals. Bacteria living in the guts of these animals feed on the normally poisonous chemicals and release energy through a process called chemosynthesis. The deep-sea communities in which these tubeworms live had been discovered about 15 years previously on the deep ocean floor off the Galapagos Islands.

Looking at these slides, I had one of those "eureka" moments that we all hope for sometime in our scientific life. I turned to my wife, Nancy, and said "Oh my God! I've seen

The picture that has emerged is of an Ontario "Burgess Shale." At Hepworth, I discovered hundreds of vertebrate mouth apparatuses, each with up to 15 conodonts still arranged as they were 430 million years ago.



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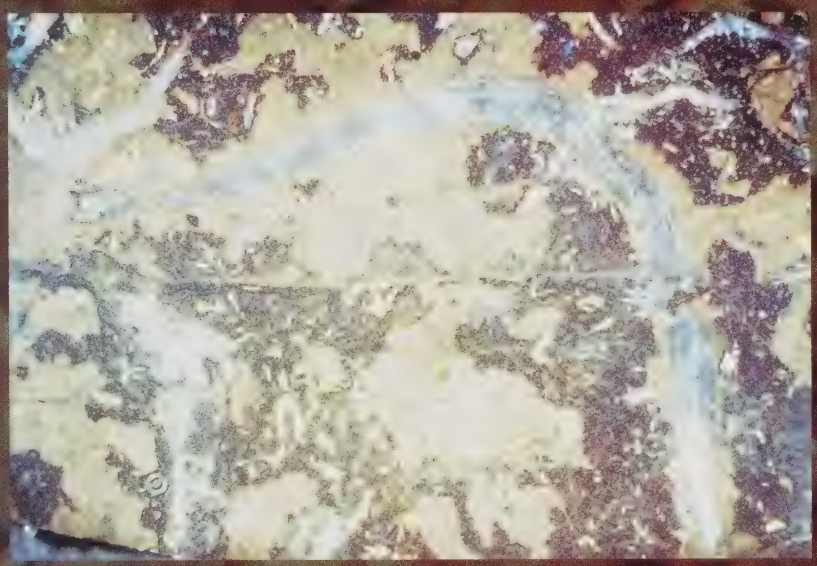

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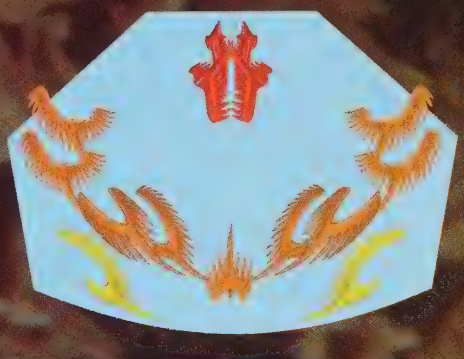


ILLUSTRATION BY MARIANNE COLLINS/KATHY DAVIS

ROM/ 56092 / M.A. PURNELL

DAVID RUDKIN

ILLUSTRATION BY MARIANNE COLLINS

Top: Reconstructions of the conodont animal, an eel-like, jawless vertebrate. **Middle left:** The first known conodont animal (bluish-coloured) associated with fossil shrimp (whitish). Granton near Edinburgh, Scotland. **Bottom left:** The "Thanksgiving Fish," a jawless fish with a bony-plated shell, at 430 million years old, is the oldest complete vertebrate known from Ontario. Park Head, Ontario. **Bottom middle:** The "Thanksgiving Fish" under ultraviolet light at about actual size. **Middle right:** Reconstructed *Gondolella* mouth apparatus with 15 conodonts. Food was captured and ingested by the anterior (yellow and orange) conodonts, and moved along to the posterior (red) cutters and grinders. **Bottom right:** The quiet tropical lagoon in which conodont-bearing vertebrates lived with sea-scorpions (shown), 430 million years ago. Bruce Peninsula, Ontario.

Ice Age Answer Found in Stone

When ROM archaeologist Peter Storck, then a young and struggling curator like me, walked into my office in 1978, another important and serendipitous research project began. Peter had learned that as an undergraduate at Acadia University I had searched for the sources of stone used by Nova Scotia's earliest Paleo-Indian inhabitants 10,600 years ago. Could I do a similar thing for him here in Ontario?

Paleo-Indians living in Ontario at the end of the last Ice Age left behind characteristic stone tools as their calling card. What Peter Storck knew was that those who lived near Stayner, Ontario, used a specific kind of chert, a type of fine-grained quartz, to make their tools and weapons. If I could discover where they got the chert on which their lives depended, then his research might go in new and interesting directions.

I accepted Peter's challenge and was joined by Betty Eley, who had studied chert from Manitoulin Island for her Master's degree. Chert from different sedimentary bedrock sources contains different microfossils, and Betty was one of the first to use microfossils to distinguish chert from different stratigraphic levels and locations. Betty's and my ensuing studies of local cherts and the microfossils found within them led to the 1989 ROM publication *Cherts of Southern Ontario,* a field guide for Ontario archaeologists.

The story of my discovering the bedrock source of Fossil Hill Formation chert high in the Beaver Valley between Collingwood and Meaford is told in Peter Storck's award-winning book *Journey to the Ice Age,* which was excerpted in the Summer/Fall 2004 issue of *Rotunda.* Interdisciplinary, applied research of this kind is a lot of fun and I was able to lead Peter away from archaeological sites on ancient beaches, where Paleo-Indians lived and fished, to new sites high on the Niagara Escarpment, where they quarried chert and made their tools.

This work led me to study the stone resources of other Paleo-Indian groups, such as those who lived at Sheguiandah on Manitoulin Island and Mount Albion West on the Niagara Escarpment near Hamilton. It has tested me in new ways, as I put hard cash on the table to buy a weekend home in the Beaver Valley, very near the Paleo-Indians' upland sources of Fossil Hill Formation chert.

And reassurance that everything is somehow connected and remembered was provided more than 40 years after I first combed Nova Scotia for the hidden places where Paleo-Indians obtained their stone raw materials 10,600 years before. In the fall of 2005, their descendants, The Confederacy of Mainland Mi'kmaq, invited me to participate in a conference on Nova Scotia's Paleo-Indian history called Understanding From Where We Come. Returning to Nova Scotia as a scientific elder provided a special time and place to reflect on the circle of life, both the large one representing the countless generations in the lives of these First People, and the smaller one that symbolizes my own successful and happy life pursuing things of stone. Did my mother know that she was nudging me toward this special vocation when she christened me Peter, from the Greek *petros,* meaning "the stone?"

these tubes before." Ever since Charles Lyell's time, 150 or so years ago, the past has been the key to the present; with Steve Scott's looking out of *Alvin's* window, however, the present became the key to the past. Present-day observations could explain what I was seeing in 330-million-year-old rocks!

I pulled together a multi-disciplinary team to study and reconstruct the ancient hydrothermal vents of western Newfoundland: economic geologist Steve Scott, sedimentologists Paul Schenk of Dalhousie University and Ryo Matsumoto of the University of Tokyo, and myself, a ROM paleontologist and stratigrapher. We determined that hydrothermal vents were common on the eastern Canadian ocean floor during the Early Carboniferous, 330 million years ago, and that the tubeworms and other marine life they contain are among the best-developed and best preserved hydrothermal-vent animals known (see "The Sulphur Eaters" in *Rotunda,* Fall 1994).

The very hot liquids and gases pouring out of the hydrothermal vents on the deep ocean floor often precipitate as copper, zinc, lead, and other minerals when they mix with the cold sea water. This makes them of particular interest to the economic geologist and to the mining community. New mineral deposits of this kind are presently forming off Vancouver Island, British Columbia. The huge and exceedingly valuable Kidd Creek base metal deposit in northern Ontario was precipitated in such a hydrothermal-vent system during the Precambrian, about 2.7 billion years ago.

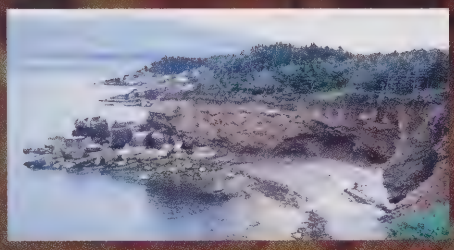
At a slightly more philosophical level, these vents are having a profound impact on our theories about the origins of life itself. It is now thought that life may not have originated in shallow, sunny marine pools as has long been believed, but rather in or around hydrothermal vents deep on the dark ocean floor.

I am grateful to Dr. Collins for his particular bias nearly 40 years ago, for my good fortune in being hired by a research institution such as the ROM, and for the many research opportunities provided me. Research needs reinforcement and nurture in a positive intellectual environment, and I've benefited greatly from working with dedicated, gifted, and truly exceptional people. Although it is not necessarily second nature to me, I've learned to talk about what I'm doing, which has often led to research projects with new and interesting people. Because clues about ancient life are often connected in ways I don't fully understand, I've also learned to keep an open mind and to recognize and seize opportunities as they come along. Experience has taught me that with help and good luck, something small and seemingly insignificant in research often leads to something larger and more important. It's also taught me that it's not always "bread and butter" research that stimulates the intellect; rather, it is the unexpected that tantalizes and challenges.

And yes, along the way, I developed a backbone, a necessary structure for surviving 37 years at the ROM. ■

It is now thought that life may not have originated in shallow, sunny marine pools but rather in or around hydrothermal vents deep on the dark ocean floor.

PAUL SCHENK


PETER VON BITTER

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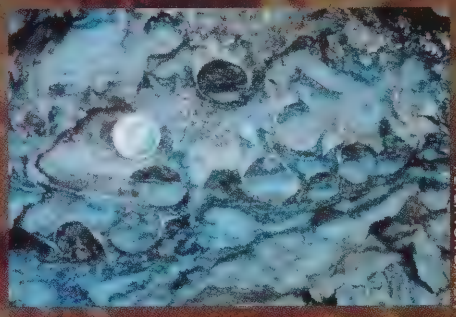
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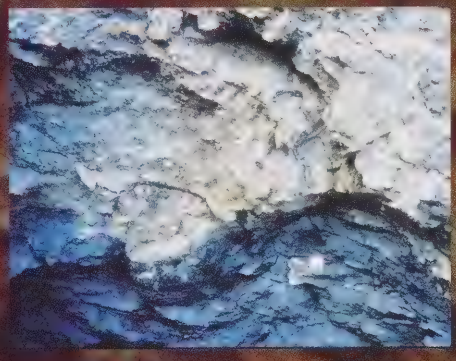
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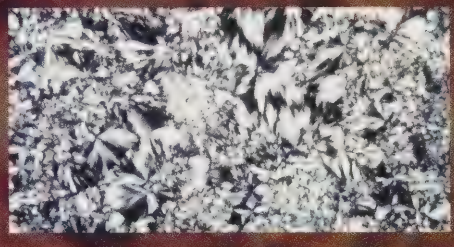

BETTY ELEY

Top left: Ryo Matsumoto, University of Tokyo, and the author, happily homeward-bound after examining evidence for 330-million-year-old hydrothermal vents in Big Cove, western Newfoundland. **Middle left:** Mistaken Cove, western Newfoundland, where tubeworms and evidence for ancient hydrothermal vents are spectacularly preserved. **Top middle:** Tubeworms with bright red gill-like respiratory plumes living at hydrothermal vents on the Galapagos Rift, off the west coast of Ecuador. **Top right:** Fossil tubeworms in cross-section, with brassy pyrite mineralization and bacterial carbonate encrustation. A dime shows scale. Mistaken Cove, western Newfoundland. **Middle right:** Fossil tubeworms in limestone overlying black shale, the latter a possible source of methane for bacterial chemosynthesis. Loonie coin shows scale. Mistaken Cove, western Newfoundland. **Bottom left:** Chert bed in the Fossil Hill Formation, exploited by Early Paleo-Indians about 10,500 years ago. Hammer shows scale. Beaver Valley, Ontario. **Bottom middle:** Characteristic "fluted" spear points of Fossil Hill Formation chert, made by Early Paleo-Indians about 10,500 years ago. Fisher Site, Stayner, Ontario. **Bottom right:** Thin-section of Fossil Hill Formation chert, showing characteristic radiating chalcedony. Beaver Valley, Ontario.

From ancient times, the afterlife was a popular concept in China, finding its way into Budd

Main Image: In the top register, this woodblock print depicts the Ten Kings of Hell conducting trials. In the three lower registers virtuous souls are either reborn as human beings to lead blessed lives or are admitted to heaven, while the souls of sinners

undergo diverse punishments before going through the Wheel of Transmigration, shown far left in the second register. The three vertical lines of large characters at the

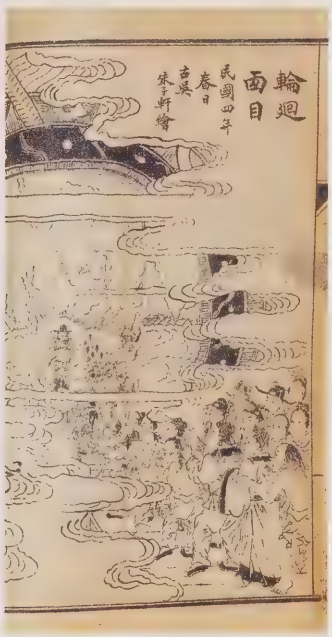
Heaven or

"Shimin's here, Shimin's here," Jiancheng and Yuanji cried as they grabbed their brother and hit him. This was no ordinary scuffle among rival siblings. Their encounter took place in the underworld—Jiancheng and Yuanji had been murdered. Now they were demanding their lives back from Shimin, the culprit who had masterminded their deaths.

This story from *Xiyou ji* (*Journey to the West*) is one of many told in Chinese books and illustrated in Chinese paintings and prints from the 10th through the 20th centuries, expressing the prevailing religious thinking of the time. *Xiyou ji*, a renowned 16th-century Chinese mythological novel, is one of the country's most popular tales about four pilgrims seeking Buddhist scriptures

d Daoist doctrines. Religious images across the ages capture these ideas of heaven and hell.

lower left corner give the title "Picture of the Judges of Hell Rewarding the Good and Punishing the Evildoer" and admonish "May those who see this be warned." **Left and right hand side images:** Two adjoining leaves from scene of purged souls lining up to



PHOTOS BY BRIAN BOYLE, ROM

go through the Wheel of Transmigration is from a Daoist moral tract printed for free distribution in 1920.

HELL

BY KA BO TSANG

beyond the western frontier of China, a work that held sway not only in its own time but for centuries afterward. In it, Shimin, the Emperor Taizong of China's Tang dynasty (r. 627–649), an actual historical figure, is cast by author Wu Cheng'en as one of the lucky few who can visit hell and return unscathed to the living world. The story goes that in a dream, the emperor agreed to save the life of a condemned dragon king destined to be beheaded by a minister named Wei Zheng. The emperor tried to keep his promise by detaining Wei Zheng with a chess game. But the minister managed to perform his gruesome task by magic while dozing off for a moment. When the dragon king's angry soul descended to hell, he brought a case against Em-

Left: "Judgment and Punishment in the 5th and 6th Courts of Hell," a hanging scroll donated to the ROM by Mrs. Mildred Amos Hayslip in 1991. The 5th King of Hell (Yanluowang or Yama) is seen in the upper right corner. He is responsible for punishing religious sinners, murderers,

hunters, fishers, and the lustful. In the lower half of the painting, the 6th King of Hell (Biancheng-wang) can be seen passing sentence on those guilty of sacrilege. **Main image, this page:** Em-

peror Taizong for breach of promise. When the emperor is summoned to hell to face his accuser, the story describes in detail the various elements of the afterlife.

Stories such as this one are of great interest to me as a specialist in Chinese pictorial arts. The ROM's collection of Chinese paintings is particularly strong in religious images, and religious texts can provide important context for the images and aid in identifying the events and figures that are depicted. Sometimes even iconographical transformation can be traced, as in the case of the bodhisattva (Buddha-in-training) Avalokiteshvara, whose gender changes from male to female over time.

Most of the ROM's Chinese paintings were acquired by George Crofts and Bishop William Charles White during the 1920s and 1930s. Except for three Yuan-dynasty (1271–1368) Buddhist and Daoist wall paintings, which have gained worldwide recognition as important Chinese treasures, most of these works have never been studied or displayed since coming to the Museum. But preparing for the small exhibition *Heaven or Hell: Images of Chinese Buddhist and Daoist Deities and Immortals*, now on display at the ROM, necessitated close study of these works. As curator of the show, I researched books and articles in the ROM's H. H. Mu Far Eastern Library and the University of Toronto's Cheng Yu-tung East Asian Library. My focus spanned the history of Buddhism and Daoism as well as the concepts of reward, retribution, and reincarnation. I also pored over mythological novels and miscellanies that tell vivid stories about experiences in heaven and hell.

In the process, a mystery that had intrigued me since 1991

peror Taizong of the Tang dynasty (bearded man in a yellow floral coat) confronting his accuser, the dragon king (figure with a scaly back holding his decapitated head with both hands, see centre detail) in front of Yanluowang. **Main image, this page:** A soul is being cut in half while another is being dragged forward to go through the same torture. Three souls that are either caged or wearing cangues (heavy wooden yokes, see detail at right) await their turn.

was finally solved. That year, an untitled painting about judgment and punishment in the 5th and 6th courts of hell arrived as a gift to the Museum. In the painting, a headless figure with a scaly back was depicted, its identity unknown. It was some 13 years later, while reading through the 100-chapter-long *Journey to the West* that I at last discovered who that strange figure was: it was the soul of the beheaded dragon king.

For the ROM's three wall paintings that have gained world renown, Bishop White had conducted pioneering research more than 60 years ago. Over the last 20 years, though, more information about the subjects in the paintings has become available—White's research needed updating.

In the spring of 2002, I was fortunate to meet an American philanthropist who became interested in my research plan to study Chinese religious paintings, in particular to search for new perspectives on the ROM's three wall paintings. He arranged two research trips for me that summer and fall— one a tour of major US museums that had comparable Chinese wall paintings and the other a visit to major Buddhist and Daoist temples in various parts of Shanxi province, China—the original home of the ROM's wall paintings. Not only did these fruitful trips enable me to see important wall paintings in both American and Chinese collections and many more still *in situ*, they also taught me much about Chinese Buddhist and Daoist art.

After my return, while going through the ROM's collection to make selections for the exhibition, I came across several woodblock prints depicting Buddhist and Daoist ideas of reward and punishment after death. One of them, entitled *A Picture of Heaven and Hell*, inspired the exhibition's title. This

print, together with the painting depicting the proceedings in the 5th and 6th courts of hell, form the two centrepieces of the exhibition, illustrating the fundamental tenets of the two religions: reward and retribution, and life after death.

Since ancient times, the Chinese have believed in life after death. During the Shang (c. 1550–1050 BCE) and Zhou (c. 1050–256 BCE) dynasties, the souls of kings and nobility were thought to ascend to heaven, while those of ordinary citizens would retire to the underworld. Beginning in the Warring States period (481–221 BCE), a clearer picture of heaven and the underworld began to emerge.

In mythological works compiled during this time, such as the *Shanhai jing* (*Classic of Mountains and Seas*) and the *Mutianzi zhuan* (*Biography of King Mu of Zhou*), heaven was often referred to as a divine palace (*tiangong*). It was located at the top of a high mountain called Kunlun in the far west, and its inhabitants were the Yellow Emperor, the Queen Mother of the West, and a host of lesser gods. As for the underworld, known variously as *youdu* (Gloomy City) or *huangquan* (Yellow Springs), it was situated on the north side of Mount Kunlun, but deep below ground.

From very early times, the Chinese believed they lived under the auspices of heaven. Supreme celestial power not only controlled the length of their lives but also rewarded or punished them according to their conduct. Consequences for their behaviour were thought to affect even future generations.

But following the introduction of Buddhism into China in the 1st century CE, this traditional view began to change. Fundamental to Buddhism, a faith that has its roots in India in the 6th to 5th centuries BCE, is the doctrine of transmigration and retribution. Similar to the earlier Chinese notion of reward and punishment, the doctrine holds that all beings, be they gods, humans, animals, or insects, must undergo successive rebirths. In each incarnation, an individual's lot is directly dependent on his or her good or bad *karma* (action) from the previous life.

The only way to be released from this cycle of birth and death, called *samsara*, which is fraught with suffering created by desire, is to follow the Noble Eightfold Path laid down by the Buddha Shakyamuni. This path provides a framework for Buddhist life, helping to nurture a Buddhist's wisdom, guide moral conduct, and fortify mental discipline. Its ultimate goal is *nirvana*, a cessation of desire and the cycle of rebirth.

Buddhist adherents can increase their chances of a good rebirth by accumulating spiritual merit. Praying, repeating mantras, giving alms, making offerings, releasing animals from captivity, disseminating sutras (Buddhist scriptures), and making religious images—such as those featured here—are some of the customary ways to earn merit.

Above: ROM wall painting fragment depicts the Buddha Shakyamuni seated on a lotus.

Buddhist scriptures assure pious adherents who invoke the names of the deities they worship that their patron saints will protect them during their lives and welcome them to various celestial domains upon their death. Those who invoke the Buddha Amitabha or the bodhisattva Avalokiteshvara, for instance, will be escorted to the Western Paradise, a realm of beauty, joy, and peace. Followers of the cult of Maitreya—portrayed on the ROM's most famous wall painting in the Bishop White Gallery of Chinese Temple Art—will be transported to the Tushita Heaven where Maitreya reigns as a bodhisattva. They will have the privilege of attending one of three assemblies to save sentient beings when Maitreya is reborn for the last time and becomes the Future Buddha. Many paintings in the exhibition depict images of these major deities to whom believers looked for deliverance.

As for non-believers and sinners, their souls will be consigned to hell, where they will suffer the most excruciating punishments to atone for their transgressions. As Buddhist scriptures describe it, hell is ruled by King Yama with the assistance of three messengers: old age, sickness, and death. Sinners are brought to King Yama, who hands down verdicts and sentences after reviewing their cases. The sinners are immediately taken away to receive the appropriate punishment.

In Buddhism hell is conceived of as a combination of eight hot hells and eight cold hells. As their names imply, the hot hells are infernos and here sinners are torn apart, sawn, hacked, crushed, scorched, boiled, or burned, while the cold hells are icy domains where sinners are subjected to bitterly cold torments. Despite sinners' wailing and begging, hell wardens mercilessly carry out their duties. Open gates automatically close to prevent the fearful souls from escaping. Worst of all, the severed, burned, or frozen souls are continuously revived so they can endure the tortures afresh.

But hell is not eternal in Buddhism. Atoned souls are

eventually allowed to be reborn and to lead one of six levels of existence: depending on the gravity of their sins, they will become heavenly beings, humans, evil deities, animals, hungry ghosts (a kind of spirit associated with perpetual hunger), or hell-dwellers (wretched beings who perform loathsome tasks in hell).

From the 5th century onwards, as more Buddhist sutras began to be translated into Chinese, Buddhist ideas of salvation and damnation became increasingly popular. They became the subject of many treatises and literary compositions. They also found expression in visual art. Murals, scroll paintings, woodblock prints, sutra illustrations, sculptures, even shadow puppetry have all survived from this period.

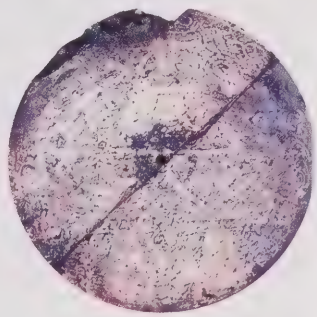
Early artwork from this large body of materials adhered faithfully to descriptions found in the sutras. But creations from later dates frequently added new aspects adapted to suit Chinese sensibilities. This is particularly evident in depictions of hell. The Ten Kings that received Emperor Taizong in hell, for example, were Chinese additions from the 9th or 10th century, when the *Sutra of the Ten Kings* was composed. In it, a hell king supervises each of hell's 10 courts: the personnel and bureaucratic procedures mirror exactly those of the Chinese legal system. From that time, the worship of the Ten Kings and related deities developed into a popular cult, with its restructured hell serving as a model for many later representations.

While the Buddhist beliefs of *karma* and *samsara* deeply affected the Chinese, another religion, Daoism, also played an important role in shaping their religious thinking over time. Daoism started out as a collection of philosophical ideas propounded by Laozi (c. 6th century BCE) and Zhuangzi (c. 369–286 BCE). These philosophers stressed the individual's personal freedom and harmony with the *dao*—the way or universal principle. Then, during the 2nd century CE certain shamans and soothsayers combined some of the sages' ideas with other Chinese notions: the *yinyang* principles, a quest for immortality, worship of supernatural beings, divination, magical calculation, and other popular beliefs. It was thought that the resulting indigenous religion would counteract the newly arrived Buddhism.

Contrary to the Buddhist belief that life is full of suffering, religious Daoism envisages life as an enjoyable earthly existence. In this view, since life is a strictly happy experience, maintaining a healthy body to prolong life is of the utmost importance. To nurture the *qi* or vital energy that sustains wellbeing, a Daoist adept must pay close attention to personal hygiene, proper diet, exercise, and meditation. Ingesting elixirs is also desirable—if the adherent can afford them. Even so, an adept must supplicate to the deities for fulfillment of worldly desires and for protection against evil forces.

In Daoist life the highest goal is to become an immortal. Different categories of immortals exist. Some are believed to have ascended to heaven in broad daylight because they had either discovered a secret formula in alchemy or demonstrated acts of extraordinary virtue. Others became immortals by submitting their corpses, including both the *po* (body) and the *hun* (soul), to a refining process in the northern reaches of the universe. After the corruptible substances—the agents of aging and dying—are destroyed, the corpses are transformed into imperishable matter and their owners now qualify to hold office in the bureaucracy of the otherworld. A small elite of Daoist holy men, so it is said, were able to transform their bodies into imperishable matter while still living. They abstained from eating cereals, meat, and ale, consuming instead only cypress or pine seeds, conifer resins, and mica.

In Daoism, immortals are believed to live in various realms. Higher immortals are thought to dwell in a celestial kingdom composed of 36 heavens while lower immortals live on land—on mountains, in subterranean grottoes, or on faraway islands. A very rare Yuan-dynasty handscroll recently acquired by the ROM through the generosity of Charles and Marilyn Baillie depicts the fabled abodes of Daoist immortals including the best-known of the realms, the Three Isles of the Blessed—Penglai, Yingzhou, and Fangzhang. These mountainous domains are in the Eastern Sea, surrounded by tem-



Top: A disc-shaped coffin ornament is engraved with the Queen Mother of the West accompanied by a winged tiger and a dragon in the upper half and a guardian seated between two towers connected by a bridge in the lower half. A two-character inscription, tianmen, identifies it as the Gate of Heaven. **Bottom:** The Future Buddha Maitreya expounding the tenets of Buddhism is depicted on a Yuan dynasty wall painting.

Left: Section from "Isles of the Blessed," a long handscroll painted by Puguang in the early 14th century. **Main image, this page:** Immortals fly on phoenixes and cranes (see detail at left bottom) to one of the Three Isles of the Blessed surrounded by tempestuous waves. The main image is a detail of the section shown in the panel at top left. The precipitous nature of the isle and the roiling sea render this sanctuary unapproachable by mortals.

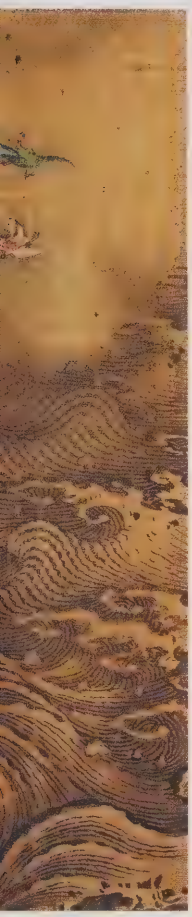
pestuous waves that render them unapproachable by mortals. Herbs, minerals, and springs on the islands are all capable of prolonging life. The immortals live in magnificent mansions. They roam at will, enjoying carefree lives in the company of fabulous birds and animals.

Like Buddhism, Daoism places great emphasis on moral cultivation. In the vast Daoist pantheon, certain deities, such as the three officials of heaven, earth, and water, as well as the star spirit of the Northern Dipper and the god of the hearth, are believed to keep a close watch on people's conduct and to report their findings to divine powers at regular intervals. Based on these reports, good people will be rewarded with longevity, wealth, prosperity, fame, success, and filial descendants while bad people will be punished with poverty, illness, disgrace, accidents, and unfilial children.

A system of merit and demerit has also been devised to guide Daoist practitioners. Providing a gravely ill person with magical charms and medicine, for example, is worth 10 merit points; killing a person, 100 demerit points. Accumulated merits can be cancelled if someone close to reaching the quota required to become an immortal commits a crime. (The exact quota changed from one time period to another and from one sect to another.)

In its doctrine of reward and retribution during one's lifetime, Daoism adopted the Buddhist concepts of hell and reincarnation and assimilated traditional folk notions about the afterlife. In Daoist understanding, as reflected in woodblock prints and sculptures created during the Ming and Qing dynasties, good souls will go directly to heaven, while blemished and wicked souls will be judged,

Main image, this page: Immortals live in magnificent mansions and enjoy carefree lives in the company of fabulous birds and animals. The main image is a detail of the section shown at top right. In the detail at bottom right, three immortals standing on the edge of the shore ob-



serve their surroundings complacently, paying no attention to their safety as waves churn in the sea.

punished, and reincarnated as one of six beings: dignitaries, destitute people, quadrupeds, birds, aquatic organisms, and creepers.

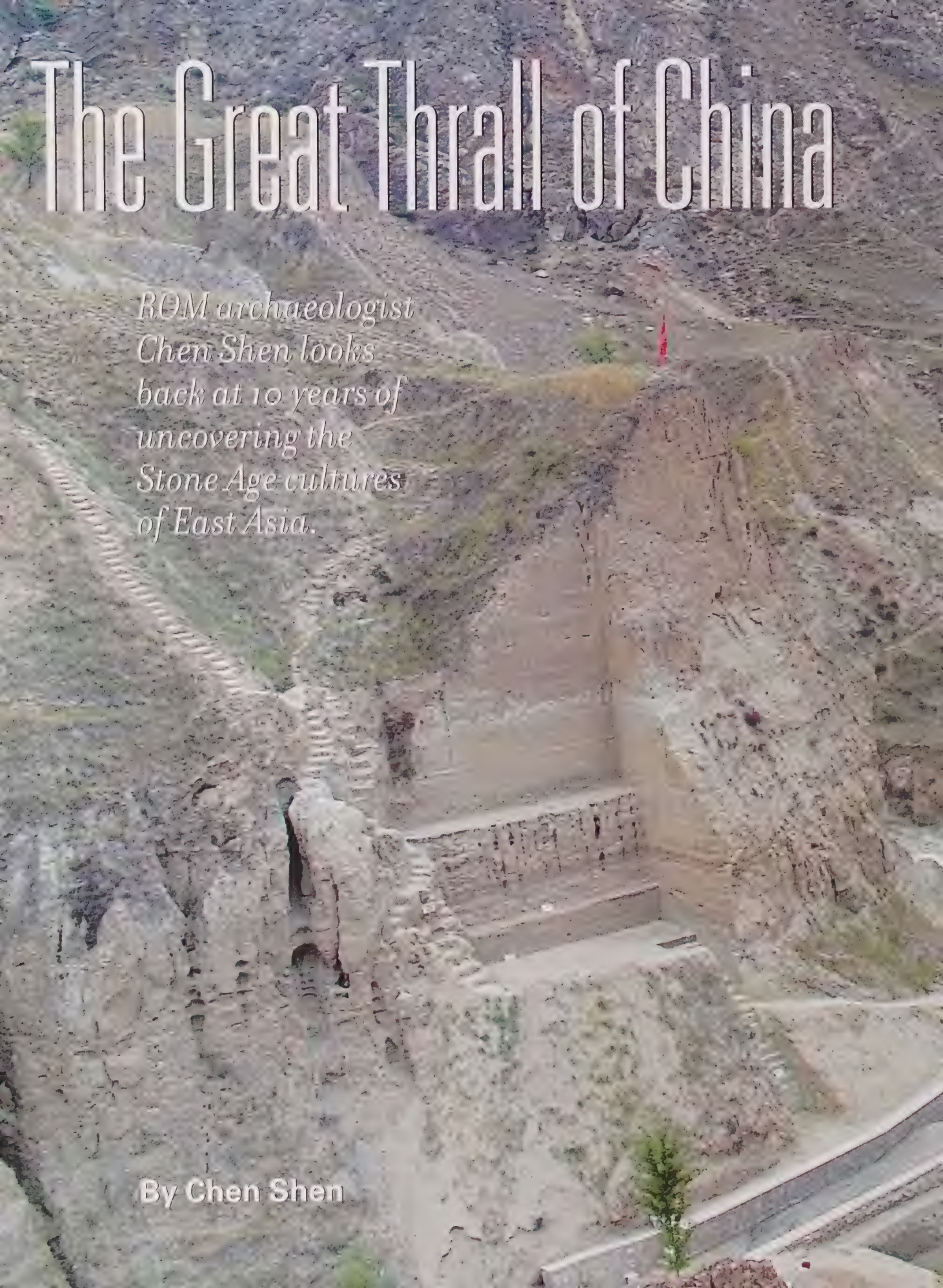
During the long course of its development, Daoism absorbed many Buddhist ideas. This is why Daoists believed in an afterlife and reincarnation while at the same time they longed for the blissful existence of an immortal.

Both Buddhism and Daoism promote belief in an afterlife, claiming that heaven, paradise, or immortality awaits pious adherents, while hell or bad rebirth is the dismal lot of devious followers and unbelievers. While rules of salvation and damnation differ, both religions agree that adherents must follow the right course of action during their lives to ensure a promising future beyond.

As for the ROM's wall paintings, during my half a year's research for *Heaven or Hell* I was able to identify several of the figures depicted in both Buddhist and Daoist works. The two seated bodhisattvas in the *Paradise of Maitreya*, for example, have now been re-identified as Asanga and Vasubandhu. The multi-armed guardians in the pair of paintings *Homage to the Highest Power* now have names—Marshal Tianpeng on the east wall and Marshal Tianyou on the west wall. I also uncovered stylistic relationships between these Buddhist and Daoist wall paintings. Both were likely produced by the same workshop in southern Shanxi province. But perhaps most amazingly, in the Green Dragon Monastery in Jishan, China, I found a painting almost identical to the *Paradise of Maitreya*—an astonishing find in the same Chinese county from which the ROM's prized painting originated. ■

The Great Thrall of China

ROM archaeologist Chen Shen looks back at 10 years of uncovering the Stone Age cultures of East Asia.



By Chen Shen

Nihewan Paleolithic sites in 2008, including
Majuangou and Goudi, the latter dated to 1.63
million years ago – the earliest hominid occu-
pation in East Asia.

"We don't expect you to sit behind your desk quietly," said Dr. David Pendergast, the ROM's vice-president, Collections and Research, when he offered me the Bishop White Curatorship in 1996. "We'd like to see you working in the field as much as you can." For me, the new and youngest field archaeologist at the ROM, this was exciting news. And what an inspiring role model Dr. Pendergast was, with his track record of conducting archaeological work in South America for more than six months a year some years! I've never been able to match his record.

Over the past decade, though, I have spent two to three months every year conducting archaeological fieldwork in northern China. The most frequent question I get from my colleagues and the public is "What did you find?" The answer is not so easy. I wish I could say I'd made a huge discovery of exquisite bronzes or lacquers from royal tombs. Instead I have to admit that what I dug up was lots and lots of broken rocks and bones. But in these unspectacular artifacts, I am searching for clues that hold the story of our human past, the history of humans' most remote ancestors in East Asia.

When I first started at the ROM, I didn't know exactly what I would do. This may sound bad; today's archaeologists would have a detailed plan of what they expect to discover before even going into the field. Based on data from previous digs, archaeologists are able to hypothesize what happened in the past and predict where they will discover the cultural materials to prove it.

In my case, when I sat in a nearly empty office in the first month at my new job, I had little idea what I would discover in China. I had spent the previous seven years working on North American archaeological materials. Certainly China was not strange to me, having lived there most of my life, nor was conducting a field archaeology program. I began doing archaeological work in China in 1984 and had continued digging in the Yangtze River Valley until I came to North America in 1990.

Through my fieldwork both here and in China I developed an interest in prehistoric stone tools. By examining how stone tools were made and used by prehistoric hunter-gatherers, I try to make sense of how our remote ancestors lived. At university in North America, I learned an analytic technique called use-wear analysis, a method of examining stone tools under the microscope to detect scarring, scratches, polish, and other small clues left on tools by regu-

lar use. By observing these patterns of wear I can tell whether tools were used for scraping hides, cutting meat, or other activities.

Archaeologists are fascinated by the possible explanations for how the various tools were used. Back then, I had no specific theory about life in Paleolithic (Stone Age) China, but I did know that the use-wear technique had not yet been used in China, so I would be able to introduce it to the study of Chinese materials. I also knew there were many archaeological remains in China waiting to be studied. All I needed to do was find a site and start digging.

Luonan Basin Project

Luck was on my side. Before long an old university buddy of mine contacted me. Wang Shejiang and I knew each other quite well back in 1982 when we shared a dorm room. He went on to study under renowned paleolithic archaeologist Prof. Lv Zen'er and as an archaeologist at the Shaanxi Provincial Institute of Archaeology he began investigating sites in China's Shaanxi province.

Two years before I started at the ROM Wang sent me a letter saying he had found a cave site where we could probably recover *Homo erectus* fossils. It was tempting to join him, but because I was rushing to finish my PhD dissertation at the time I decided against the trip. When Wang contacted me again in 1997 to say he was planning another excavation of the cave, I asked if I could now join his team. "Sure," he said. The best thing I heard for years was that I didn't even need to worry about research funding. He had it covered for the year. "Just bring yourself and your brain," he said.

I met Wang at Xian International Airport. I hadn't seen him since our graduation from Wuhan University 10 years before. He still had the same attractive smile I remembered, but less hair and deeply tanned skin from working in the field. It took some eight hours to drive to our site in a 1970s-era jeep, spiralling up and down the Qinling Mountains. Our destination, near a village called Jianzui in the Luonan Basin, was Longyadong Cave.

During those first two months, I had no laptop computer, no global positioning system (GPS), no digital camera, or any of the other digital devices I would later rely on. Nevertheless there I was, on July 10, 1997, standing in front of a Stone Age cave site in northern China. When I dug my shovel for the first time into the loose soil, I was overcome with emotion. This marked the ROM's first scientific archaeological project in China.

There was reason for that emotion. From its beginning, the ROM has supported an extensive research program. ROM archaeologists have worked around the globe studying our renowned collections. But for many years archaeological work in East Asia was not possible. In the 1940s, China closed its door to foreign archaeologists and it was not until almost 50 years later, beginning in the early 1990s, that limited collaborations in archaeology were once again permitted.

So, while the ROM houses the most comprehensive collection of ancient Chinese art outside China, most of it comes from archaeological sites excavated before the 1940s. The patrons of these collections, who acquired them in the early days, such as George Crofts, Bishop William White, and James Menzies, had a great fondness for Chinese cultures and archaeology. The items they collected therefore came to Toronto with a rich history of where and how they had been found. Now, all these years later, in the early 1990s, my Luonan Basin project became one of the few established Canadian archaeology projects allowed into the newly re-opened China.

The Cave of the Dragon Tooth (the name of Longyadong Cave in translation) in Luonan Basin is known to the local villagers for its buried fossils, which they call "dragon bones." A few families in the village (including that of our primary field assistant, Shuiming) had made a fortune selling cartloads of bones to local drug stores as additives for herbal medicines. It was in one of these stores that a Chinese geologist identified a *Homo erectus* tooth in 1977. The published report of the find caught Wang's attention and prompted him to investigate the cave.

In his previous two field sessions at the cave, two and a half metres (more than 8 feet) down, he had hit the jackpot—a layer of original human occupation with stone-tool flakes and fossils together with cooking hearths and ash-pits. It had been excavated in 1995 and 1996.

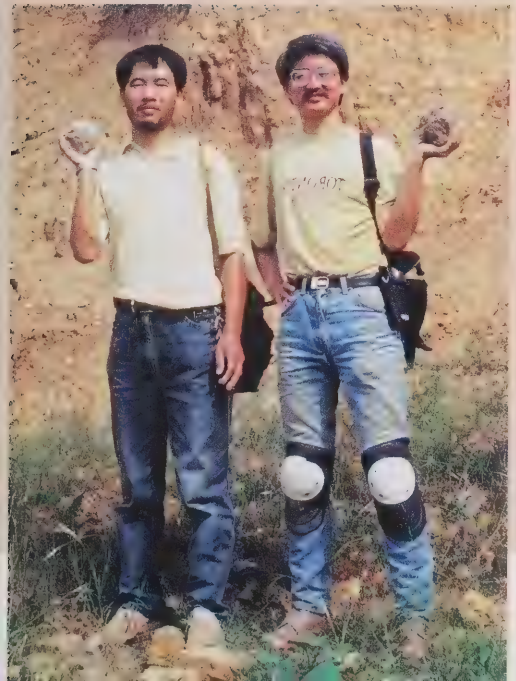
The job in 1997, as Wang put it, was to "find the damn hominid skull and finish

WEI QI

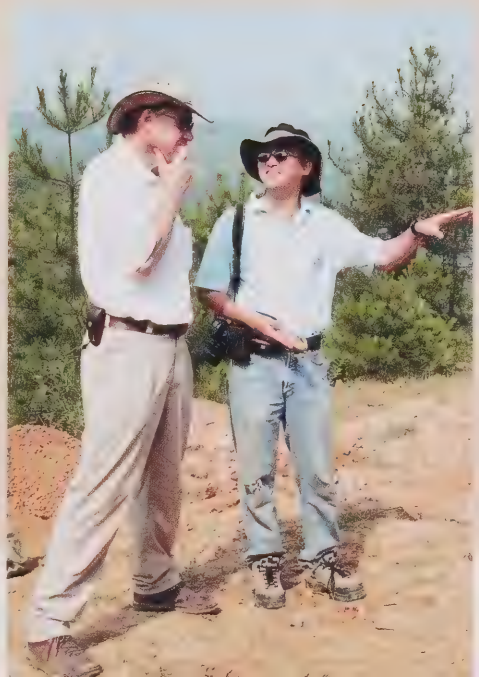
WANG SHEJIANG

Ten years in China

Inset: Map showing the locations of the three ROM-China projects. **Top:** Chen Shen examines artifacts *in situ* at the Maliang site in the Nihewan Basin in 2006. **Bottom, left to right:** Chen Shen in 1997 enroute to the Longyadong Cave in the Luonan Basin; Chen Shen and Wang Shejiang in 1997, surveying Palaeolithic sites in Luonan Basin, holding artifacts from a site they had just identified; Chen Shen and Dr. Richard Cosgrove from La Trobe University, Australia, discussing the design for excavating site LP269 in Luonan Basin in 2006; Prof. Wei Qi from the Institute of Vertebrate Palaeontology and Palaeoanthropology, Chinese Academy of Sciences, in Nihewan in 2006, 29 years after he started searching for hominid fossils there.



HELEN HAINES



CHEN SHEN

up here." Anticipating finding the ancient users of this cave, the team worked around the clock. The only break was a three-day hiatus when a rainstorm flooded the log bridge connecting our village to the outside world. In the cave we found more than 77,000 stone tools, the highest density of cultural remains ever found from a single cave in China except for the renowned and very large Zhoukoudian Cave near Beijing.

Of the more than 20 species of faunal remains, deer bones and teeth predominated, indicating that the cave-dwellers must have been hunting deer for food. But to our dismay, there were no hominid fossils. Our diligent helpers from the local villages were even more disappointed—they would not be able to claim the 20-inch colour TV set we had promised to the first person to find hominid fossils. But it was clear that hominids had been there; evidence of stone tool manufacture and traces of fire use, such as hearths and ash-pits, were telltale signs.

On subsequent trips, we surveyed a 30-kilometre (18-mile) radius around the cave in Luonan Basin, eventually identifying 268 Stone Age open-air sites and collecting more than 13,000 lithic, or stone, artifacts. We hadn't expected to find evidence—in the form of these artifacts—of such a dense hominid population. Later, we speculated that the area had once been a hominid corridor through the highlands between northern and southern China.

While examining the stone tools we had recovered I noticed something interesting. In the cave, most of the tools we found were small in size, flake tools made from flakes of stone struck off a core and modified into scrapers, points, and burins likely used for meat processing. The tools found in the nearby open-air sites, by contrast, were predominantly large cutting tools, such as hand axes, cleavers, and choppers. This discovery made us wonder why the hominids in this region used different tool types in different places.

Two possible explanations sprang to mind. The first was that two unrelated groups of hominids possibly from different time periods may have been exploiting resources in the same area and the tools they made would have reflected their respective cultures. Alternatively, the same group of hominids may have occupied both cave and open-air sites, perhaps seasonally, conducting activities in each that required two different tool kits. To find the answer, we needed to find out how old the sites were. If the dates of the cave and open-air sites did not match up, the first scenario would be more likely; if the dates were similar, the second would be more probable.

We dated the cave to about 400,000 years ago using a method called thermoluminescense, in which samples of clay are burned and the amount of heat preserved provides a date. The samples indicated that Longyadong Cave was probably occupied for at least 200,000 years.

Incidently, this was the same time period that another group of hominids, the famous *Peking Man*, lived in Zhoukoudian Cave about 150 km (93 miles) to the east. When the Zhoukoudian fossils were found in 1929, they were the first scientific evidence of human evolution and they represented the earliest known hominid in the world. Since then, the date of our earliest ancestors in East Asia has changed, pushed much further back thanks to a later ROM-China project that I would later spearhead.

But before we could date any of the open sites, the Luonan project came to a halt. Wang went to Australia to pursue a PhD. I heartily supported this move, knowing we would again return to this fascinating region. But his decision left me a bit sad, wondering how I would continue my field archaeology project. I had a grant for the Luonan project, but without Wang I had no site to dig.

Nihewan Basin Project

Fortunately, I soon heard from an acquaintance, Dr. Chen Chun, a professor from Fudan University in Shanghai, who was looking for funding for a promising Chinese project: a search for the earliest hominids in Nihewan Basin. I had met Dr. Chen in Toronto a few years earlier while he was digging in Ontario. Like me, he was a specialist in paleolithic stone tools. A shy scholar in his mid-40s, Chen had taken his training under prominent archaeologist Jia Lanpo, discoverer of the *Peking Man* fossils. The Nihewan Basin endeavour provided a perfect match: Dr. Chen had the project and I had the funding.

The ROM collaboration at Nihewan started in 1998 and continues today. Over

WANG SHEJIANG

CHEN SHEN

Luonan Basin Project

Inset: Hand axes recovered from the Luonan Basin. **Top:** Chen Shen enroute to Longyadong Cave in the Luonan Basin in 1997. **Bottom, left to right:** Landscape of a valley in the Luonan Basin at the Longyadong Cave site; the team working at site LP055 in 2004; Chen Shen working at site LP269 in 2006.

CHEN SHEN

CHEN SHEN

HELEN HAINES

the last eight years, we have investigated many Early Pleistocene (30,000–10,000 BCE) sites, more than a dozen of which date prior to 1 million years ago. The Nihewan Basin sites have yielded abundant cultural materials indicating that hominid activities took place there, although as yet no hominid fossils have been uncovered.

On a hot day in July 1998, I arrived with Dr. Chen at nearby Donggutuo village and made a dramatic entrance—while asking a local villager for directions, I passed out. I had a fever of 39.7 C, possibly caused by poor air circulation where I had been staying. A local doctor who travels from village to village on his motorcycle gave me an antibiotic shot. The Jias, our host family, bestowed on me the Chinese tradition of great hospitality, helping to speed my recovery. Three days later, I was well enough to climb the hills to check out a site called Xiaochangliang, where we planned to dig.

Identified in 1978, Xiaochangliang was the first known Lower Pleistocene site in the Nihewan Basin. Because of its great antiquity, it attracted much attention from international scientists—archaeologists, geologists, paleontologists. But no systematic excavation had been carried out until the 1990s. A site survey and surface-collected materials indicated it was an area of hominid activity. We began excavating using the latest technologies—a digital camera, a GPS handheld device, and a computer database application for recording, all of which astounded my Chinese colleagues who had never seen such things before.

We soon arrived at a firm date for the site. It was astonishingly early—1.36 million years ago. At the time, it was the earliest known date of hominid occupation for the region. But this soon changed again.

During my first year at Nihewan, I met Wei Qi, whom I regard as one of the greatest archaeologists I've ever known. As a senior archaeologist at the Institute of Vertebrate Palaeontology and Palaeonanthropology (IVPP), Chinese Academy of Sciences, in Beijing, our partner in the ROM project, Wei has devoted more than 30 years to the Nihewan region, tirelessly searching for hominid fossils. He is a typical northern Chinese—tall, warm, and straightforward. And, best of all, he was interested in what my North American training could add to the project.

We found a jumble of stone tools and fauna bones that our initial study suggested had been inundated with water at some point. Sediment analysis showed that the site was once the shoreline of an archaic lake. Microscopic examination revealed that Xiaochangliang hominids used unmodified flakes as handy tools. They may have been using them, according to our use-wear analysis, for the scavenging of dead animals for food.

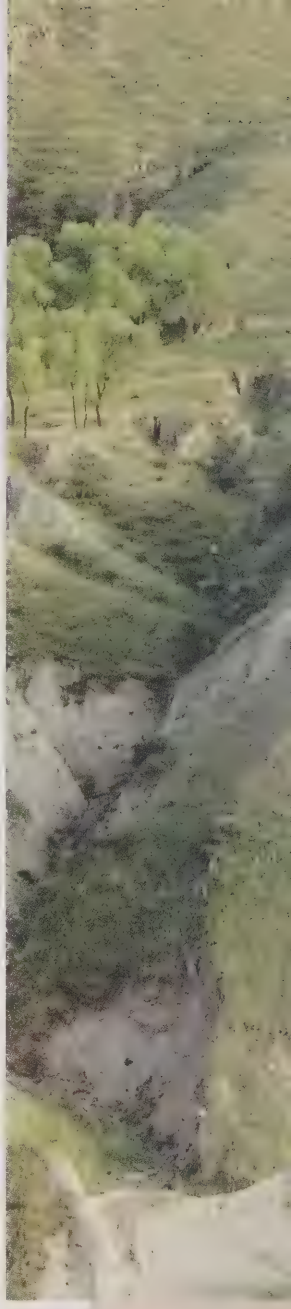
In 2000/2001, the ROM Nihewan project held field sessions at another important site, Donggutuo, which Professor Wei had identified and excavated in the early 1980s. It is the only known multiple-layered Lower Pleistocene site in China, with the different layers representing different periods of occupation. We dated the site to 1.1 million years ago and recovered 2412 artifacts. Detailed analysis of this material is still in progress.

But the most exciting find at Nihewan was the Goudi site, discovered in 2001. Here we found more evidence of hominid presence. We collected stone artifacts and something we hadn't seen before: remnants of tool manufacture, or tools that can be fitted back into a "core" from which they had originally been flaked. Bone and tooth fossils from a range of animals, such as hyena, horse, and deer, were mixed with ostrich eggshells and water chestnuts. Cut-marks on the bones indicated that some of these animals were part of the hominid diet.

What excited us most about the Goudi site was that it has allowed us to trace hominid activity back even further than the Xiaochangliang site—to a record for China of 1.65 million years ago. Another site excavated in 2006 could be even slightly older than Goudi.

Although there is much work still to do in the region, we believe we have uncovered cultural remains of the earliest hominid occupations in East Asia. In the future we will try to answer two questions: What conditions attracted hominids to the region, and what kind of lithic technology did the hominids use on their journey to the East to create cultures in northern China?

In the summer of 2006, when I returned to Nihewan with some Chinese students, much had changed since my first trip. Today, it is much easier and more comfortable to access our field sites and field station. Closure



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Nihewan Basin Project

Inset: Flake tools recovered from the Xiaochangliang site, dated to 1.36 million years ago. After being examined under the microscope for use-wear, these tools were found to have been used for butchering animals. **Top:** Landscape in the Nihewan Basin. **Bottom, left to right:** Excavating the Goudi site in 2004; Chen Shen showing artifacts to Mr Phillip Caron, former Canadian Ambassador to China, and his wife at the Nihewan Field Station in 2005; Wei Qi excavating the Dongxigou site in the Nihewan Basin in 2006.

CHEN SHEN

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of the mud byways to our sites on rainy days is a thing of past. A two-lane road neatly paved and flanked with trees now leads to a visitors' area in front of our workstation. This easy access has drawn both local authorities and international scholars to the impressive site—including then Canadian ambassador to China, Phillip Caron and his wife.

Shandong Project

Back in 1999, before the Nihewan collaboration was officially signed, I was still searching for a collaborative field project in China—in case the Nihewan project fell through. In Beijing for a conference, I met Dr. Chen Xingcan from the Institute of Archaeology, Chinese Academy of Social Sciences. Dr. Chen's team had excavated three Paleolithic sites in Shandong, but the artifacts had not yet been studied. After examining these lithics at Qufu workstation—where I would later build a special lithic laboratory—I made up my mind to sign on to the Shandong project.

What made it exciting was that an unusual technique had been used to make the tools found at Shandong—the microblade technique. Toolmakers needed special skill to produce these small blade tools. Their precision work left behind telltale wedge-shaped cores. The microblades were probably used as barbs inserted in wood points to make a composite hunting tool. This finding is significant because during the end of the Late Pleistocene, microblade technology was common to both sides of the ocean—in northeastern Asia and in northwestern North America. Most scholars have seen microblade technology as compelling evidence that people from northern China were probably the first to people the New World.

Shandong province in east China was in the middle of a migration route and thus represents an intermediate region in which technology was transmitted from one place (presumably the western end of north-central China) to another (northeastern Siberia or Japan). Future studies exploring the origin and development of microblade technology may shed new light on our understanding of the early pathways of hunter-gatherers across the two continents.

The ROM's Shandong project, initiated in 2000 in collaboration with the Institute of Archaeology of the Chinese Academy of Social Sciences, proved to be significant. Over the past six years, we have excavated three archaeological sites, conducted five field surveys, and completed four sessions of lab analyses (since Chinese archaeological materials cannot be exported). With my Chinese colleagues and field assistants, I have catalogued, classified, and analyzed nearly 10,000 artifacts from the Qufu workstation.

Before this project began, Shandong's Upper Palaeolithic was considered to have a single microblade tradition called "Fenghuangling" cultural complex, which is highly regarded as having been an important regional lithic industry in ancient China. But from the time of the site's discovery in 1982 there had been no detailed study of it, and the nature and distribution of the ancient culture that produced it was not known.

Through our investigations, we have entirely changed the traditional views of this Upper Paleolithic culture. Shandong's stone tool technology was much more complicated than previously thought; instead of a single microblade tradition, I have identified at least four traditions in the region.

As well, based on limited radiocarbon-dating samples, we have established a rough age for the area—from 20,000 to 6,000 BCE. Detailed analysis of the stone tools—their manufacture and function—gave me extensive knowledge of the region's microblade tool-making history, which will allow us to compare the methods used in Shandong with microblade techniques in other regions, especially those from the coast of western Canada.

Last but not least, we identified some new cultural traces that had been overlooked by previous scholars. I discovered, for example, that bifacial technology—stone flake tools that have been trimmed from both sides—was used to produce microblades. In particular, we discovered a version of the bifacial point called a "flute" point, which has a channel flaked from its surface from bottom to top. Finding this technology type in China is important because the earliest known stone tool technology in North America is extremely similar.

The North American version is a fluted projectile tip called the "Clovis" point. It is so closely associated with the earliest occupants of North America (at ages of 12,000 to

CHEN SHEN

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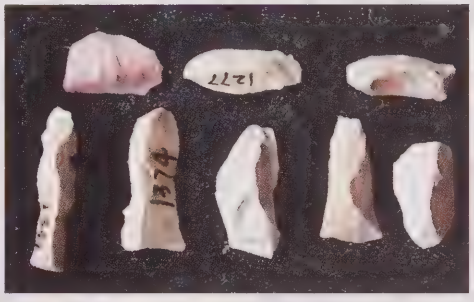
Shandong Project

Inset: Microblade tools recovered from Shandong Palaeolithic sites. **Top:** Excavation at the Wanghailuo site in Shandong in 2001. **Bottom, left to right:** A cave house where the archaeological crew stayed while working on microblades in Shanxi province; the team preparing for fieldwork at the outdoor eating area during the 2005 field season; lithic laboratory (top) at the Qufu workstation, established for the Shandong project; inside the cave house (bottom) where Chen Shen stayed while working in Shanxi province; the Shizhitan site, Location 12, and surrounding landscape in 2005. **Inset, (next page):** Chen Shen in 2006 in the Nihewan Basin.



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Migration Theory

Around 40,000 – 35,000 BCE, in China as elsewhere, dramatic cultural changes occurred—including the sudden appearance of various new stone tool technologies. These changes were likely related to the origin and spread of modern humans. The technologies they brought to northern China mixed with indigenous methods of stone tool manufacture to form a unique Upper Paleolithic culture in China's north.

My theory is that migrations of modern humans from the west—via the vast Eurasian Steppe and Eastern Siberia—undoubtedly contributed to the complexity and variability of the Upper Paleolithic stone industries in northern China. By the end of the Pleistocene (30,000 –10,000 BCE), the culture in northern China was part of a larger cultural complex sharing similar technology that eventually reached the New World certainly by 11,500 – 9,500 BCE but quite likely earlier.

Our Shandong project suggests that the cultural transformation in northern China during this transitional period may have resulted from interactions with hunter-gatherer societies from farther north. While hunter-gatherers from the west migrated eastwards and across the land bridge that once connected China to North America, another wave of migration must have moved from east Siberia southward into northern China, where the migrants interacted and integrated with the indigenous hunter-gatherer societies. The cultural complexity we are investigating in Shandong Peninsula supports this hypothesis.

WEI QI

Dr. Chen Shen's research in China is currently supported by grants from the ROM Governors, Canada's Social Sciences and Humanities Research Council, the US-based Wenner-Gren Foundation for Anthropological Research, the Australia Research Council, and the Chinese Academy of Sciences.

11,000 BCE) that it is considered diagnostic evidence of their presence. Scholars have agreed that such technology used by the first peoples in Ontario, and on display in the ROM's Gallery of Canada: First Peoples, is of North American origin. The three specimens we've uncovered in China are the *only* examples known from the country. But they may prove to represent a larger flute culture, and if so, the technological connection between the Old World and the New can be further explored, and models for the peopling of America will have to be revised.

We are still a long way from this, but we now have a much better understanding than when we started in 2000.

In 2004, the scale of the work suddenly hit me. I had firmly established a research partnership with the Institute of Vertebrate Palaeontology and Palaeoanthropology for our work in the Nihewan Basin. I had returned with my friend Wang to the Luonan Basin site with a large team, to pick up where we had left off when he went to get his PhD. And I was continuing with the Shandong project. I was now running three ROM-China paleolithic projects, all with the potential of exciting outcomes.

But potential can't be realized without funding. The days in 1997 to 1999 when I was worried about how to establish a collaborative project in China are now a thing of the past. Back then, I was desperate for funding. A couple of my grant applications had been turned down for lack of a solid research agenda and collaborative initiatives. Now, the ROM's China projects are supported by five funding bodies in four countries.

The work has kept me very busy. But I am very pleased to be spearheading an area of research that 10 years ago I had merely wondered about. The three ROM-China projects are now well positioned to provide new perspectives on the development of paleolithic cultures from the earliest hominids in East Asia and the peopling of the Americas.

In the early days, when the ladies from the ROM's Bishop White Committee, patron of my curatorship endowment, would ask me what I found in China, I would feel some embarrassment at not having more to say about what those broken rocks and bones really meant. But 10 years later, I welcome their questions. Now I have a good story to tell. ■

Tombs of Gold

FEATURE REVIEW

Ancient Peru Unearthed / Sicán : L'Or du Pérou antique

Carlos Elera, J. Scott Raymond, Colleen Sharpe, Izumi Shimada

(Nickle Arts Museum/University of Calgary, Cloth: $39.95)

Gold, valued by the Inca for its symbolic and decorative significance although not for its economic value, adorned the civilization encountered and toppled by the swashbuckling conquistador Francisco Pizarro between 1533 and 1535. His false promise of freedom to his doomed captive, the Inca emperor, Atahualpa, in exchange for a large room filled with gold, led him to the Inca capital at Cuzco, where the icons of a civilization were plundered and melted into ingots. But unknown to the looters, a fabulous cache of gold objects lay entombed to the north with the rulers of a pre-Inca civilization called Sicán.

This catalogue accompanying *Ancient Peru Unearthed*, an exhibition originated by the Sicán National Museum, Peru, in co-operation with the Nickle Arts Museum, Calgary, and featured at the ROM from March 10 to August 6, 2007, documents the archaeological excavation of two elite Sicán tombs at Huaca Loro, bringing together the perspectives of an international team of scholars to illuminate the Sicán people and their world. The culture arose in the middle La Leche valley of the Lambayeque region of Peru during the period 900–1100 CE. Central to Sicán is the image of its deity, a beak-nosed figure with teardrop eyes (depicted on the catalogue cover), possibly representing the founding ancestor, Naymlap, by legend said to have arrived from across the sea by balsa raft. The 12 platform mounds at the original Sicán site were once temples composed of roofed terraces and courts. Studios and workshops of artists and artisans surround the mounds. The thousands of tombs at the site suggest that it may have been a religious capital rather than an administrative centre. Although the gold, copper, and silver used to fashion the sacred objects were obtained from nearby regions, other materials, including emeralds, amber, and cinnabar, were imported from a more distant "network of elite contacts."

Between 1020 and 1100 CE, a drought of three decades precipitated what may be interpreted as a revolt, and the temple/workshop complexes were burned. The site was subsequently flooded after a cataclysmic El Niño event and the power base moved to Túcume.

In the Late Sicán (1100–1375 CE), artistry—and especially images of the Sicán deity—declined, but construction of the great mounds persisted at Túcume, under the watch of Sicán royalty. The Sicán ended in the late 14th century at the hands of the conquering Kingdom of Chimor, who in turn were defeated by the Inca a century later. *Sic transit gloria*.

The artifacts excavated include ceramics, many of them exhibiting heads and faces; jewellery fashioned from seashells, turquoise, sodalite, amber, and amethyst; head ornaments, among them gold crowns with geometric patterning, crowns with bird and ocean-wave motifs, a gold Sicán deity mask, spool earrings, nose ornaments, gold-feather head ornaments, and gold headdresses. A miscellany of objects includes numerous renderings of the Sicán deity as well as gold disks (to decorate standards), necklaces, a gold-and-silver drinking vessel, cones, and bells.

Text is bilingual, English and French.

Glen Ellis is head of Publications, Royal Ontario Museum.

SELECTED AND REVIEWED BY GLEN ELLIS

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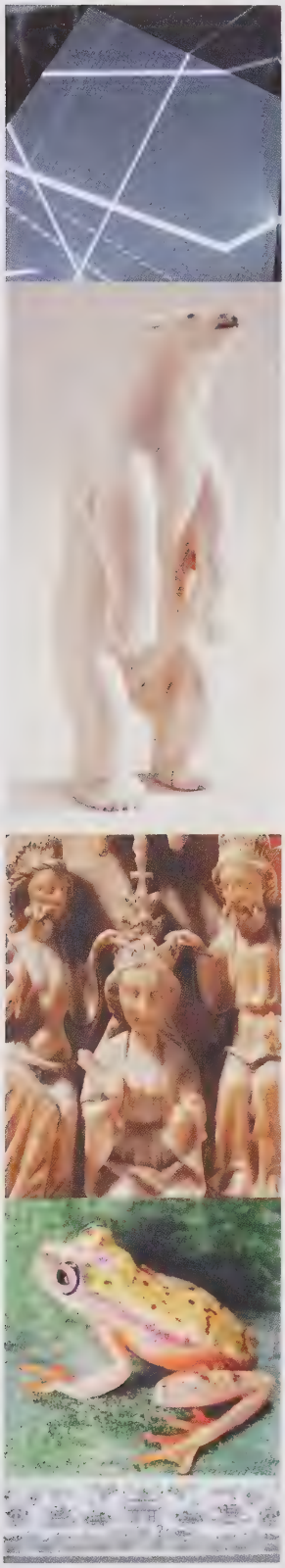

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ROM Royal Ontario Museum Governors

Comfy Slippers

These chairs that went by a variety of names in their day were the height of Victorian style.

Dear ROM Answers,

Good morning! I have a lady's Victorian spring-back slipper chair in my sitting room. I love that little chair. It was my 1967 Centennial gift from my mom—I was told the chair was manufactured in 1867. Recently, I have been looking for information about it by searching the Internet, but cannot seem to find anything. Do I have the type of chair wrongly named? There seem to be many terms used for chairs of this vintage. I wonder if it is a buttoned-back Victorian chair, a crinoline chair, an iron-back deep-tufted chair, or a wire-back lady's chair?

My husband took some very detailed photos of the chair and made a minor repair to some upholstery tacks that had come loose. While he had a corner of the muslin cover exposed I could see inside. What a mess! Canvas webbing, wood disintegrating into sawdust, horsehair, and straw among other things I could not identify. I saved a few strands of the horsehair. The back is flexible and does not seem to have a wooden frame. The front legs are turned and have porcelain castors. The straight back legs have metal castors with die-cut holes in the circular construction. We assume the frame is wire but did not dismantle the chair to find out.

What is the name of this little chair and how old is it?

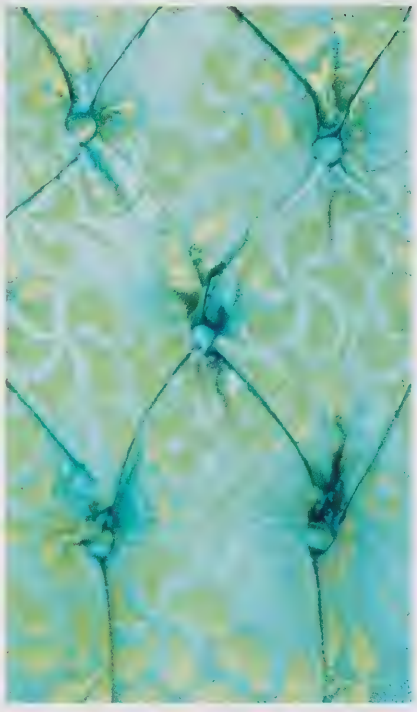
D. G., Whitby, Ontario

Dear Reader,

What a nice Centennial gift from your mother! It is interesting that you should be writing to me about an upholstered chair as I just presented a workshop on historic furniture upholstery and fabrics in October. The Museum's Textile Department helped me organize the workshop as part of the pre-conference program for the Textile Society of America. Their Toronto gathering was the first to be held outside the US. I thought it important for textile scholars to see some of the ROM's furniture with its original upholstery and textile coverings since between the Textile and European furniture collections, the Museum owns an exceptional series of upholstery examples spanning the period from about 1600 to around 1900. There is still much research to be done on the materials, techniques, and forms of authentic Victorian-period upholstery. Fortunately, considerable original material survives from 1800 onwards.

One of the most important advances in upholstering occurred around the 1830s when, thanks to improved steel and springs developed for carriages, thick wire springs came to be used in upholstered furniture. Previously, upholstery had to be meticulously built up

PETER KAELLGREN



PHOTOS THIS PAGE: AMY LATHROP, ROM

D. G.'s wire-back slipper chair with wood frame and castors and green damask upholstery. Probably Canadian, c. 1867–1890. Height: 84 cm (33 inches), seat height: 35.5 cm (14 inches).

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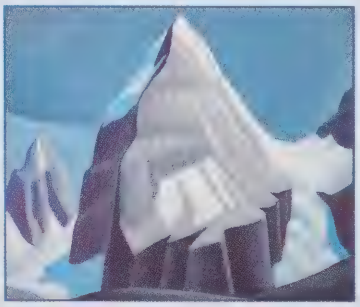

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in solid layers with coarser materials such as horsehair or grasses used as a base and covered in finer-textured stuffing. Often the stuffing was held in place by stitching with thick cord through the various layers, a time-consuming and expensive technique.

Steel springs mounted on a base of woven jute or other webbing could be held in place by strings and covered with burlap to build an ample profile for a chair seat or back in less time. Coverings were horsehair or grass, a layer of cotton padding, and finally muslin. Strings drawn through the layers, often with buttons attached, could create a puckered pattern usually called button-tufting. This tufting was the height of bourgeois luxury and was used for everything from first-class railway carriages to coffin interiors.

Another Victorian development was a reduction in upholstery prices. Before the Industrial Revolution in the late 1700s, all fabrics were hand-woven and were therefore costly. Although hand-woven and hand-embroidered upholstery continued to be made, when new machine-loomed fabrics came on the market they were available in wider widths and were often more affordable.

Wire, too, became popular in the Victorian period, as many new and improved materials and manufacturing techniques were adapted to create household furnishings and implements for the growing consumer market. Furniture factories found that the strong new wire allowed them to make furniture more quickly and cheaply. Your chair appears to be a standard wirework model. Very little wood was used to create the seat frame. The back and arm profiles were made with strong wire bent into shape, sometimes with a supporting series of wires rising from the seat. As a result, the back has a degree of flexibility.

As you have observed, the stuffing used in Victorian furniture was not always the most healthy or hypoallergenic. Grass, straw, sawdust, and horsehair (the preferred material for mattresses) were relatively inexpensive and tended to decompose over the years. For this reason, many pieces of Victorian furniture have been re-upholstered.

Wire-back furniture is difficult to date precisely, partly because it was made for the popular market and partly because the same traditional forms were made from about 1870 to around 1900. Unless you have an original invoice or furniture label that can date your chair more precisely, I would consider it to be from no earlier than 1867 but more likely from the 1875–1900 period. It may be possible to document Canadian manufacturers of this type of furniture through researching city directories and newspaper advertisements. The upholstery, which appears to be green silk damask, is appropriate for such a chair. It is likely a later replacement because of its good condition and lack of gimp or ornamental braid edging or fringes, which tend to be part of original Victorian upholstery.

Victorians and later generations have applied a range of names to chairs like yours. "Easy chair" referred to a chair that had more than the seat upholstered. An easy chair with arms, often with upholstered pads, was a "gentleman's chair"; a "lady's chair" usually had minimal arms or simple brackets, allowing space for fashionable ample Victorian skirts. Your chair would fit into this last category.

"Slipper chair" apparently is a period term used less often today. The defining feature of this chair type is the height of the seat, which is lower than the 43 cm (17 inches) found on standard side, dining-room, and hall chairs. The sources I consulted suggest your chair height corresponds to the slipper type. The name seems to come from the definition of a slipper as a light, low-cut shoe, which is easily slipped onto the foot and used in the comfort of the home. In Victorian pictures, slipper chairs are often

BRIAN BOYLE, ROM974.129.2

Slipper chair with mahogany frame and original needlepoint upholstery with beads and velvet border. English, c. 1850–1860. One of a pair given to the ROM by Mrs. E. L. Robson. Height: 85 cm (33 1/2 inches).

shown in bedrooms or beside a fireplace, where one could relax, perhaps even wearing slippers.

Like many pieces of Victorian seat furniture, slipper chairs usually have castors, which made it easier to move them to suit social situations or when house cleaning. White- or brown-glazed porcelain castors were often used on the front feet while iron or metal ones might be used for the back legs, which were less visible.

Because so much Victorian furniture survives and is on view in historic houses in Canada, ROM curators have been extremely selective, collecting only fine examples with original period upholstery. Needlework was a popular Victorian pastime, and petit point or tapestry upholstery was often made for accent pieces such as slipper chairs. The Museum owns a pair of small Louis-style slipper chairs with mahogany frames. Although the decorative details correspond to the Louis XV or Rococo style, Victorians probably referred to them as Louis Quatorze, likely because they considered the builder of Versailles the most famous and stylish of French kings. (Victorians also tended to date objects optimistically early.) The upholstery is original petit point combined with small glass beads and a velvet border.

A larger version with a frame of walnut is in the ROM's Canadiana collection. It follows the style associated with Charles Locke Eastlake (1836–1906), an English scholar whose books on contemporary interior design enjoyed great popularity in North America. The larger chair was likely made by a Toronto firm, such as Jacques and Hay, around 1875–1885. The upholstery was worked by Emma Youlden Philp (b. 1855), who married the Rev. John Miles Wilkinson. She spent her later days in a house on Huron Street, Toronto, where the University of Toronto's Sydney Smith Hall is now located. Given the unusually high back of this chair, one wonders whether Emma got carried away with her needlepoint . . . or simply came from a family of very tall people.

Thank you for sharing your chair with our readers. I also thank Elizabeth Phillimore Busby for sharing family information with us.

BRIAN BOYLE, ROM973.416.1

Slipper chair with walnut frame and original needlepoint upholstery. Canadian, probably Toronto, c. 1875–1885.

The upholstery was worked by Emma Youlden Philp. Gift to the ROM from Mrs. Elizabeth Phillimore.

Peter Kaellgren is curator of European Decorative Arts in the ROM's Department of World Cultures.

Screen Idol's Embroidered Gift

Sewing up a royal provenance

ROM ARCHIVES

When an artifact comes into the ROM's collections, establishing its provenance is one of the curators' first research priorities. This embroidery for a chair cover from the ROM's Textiles collections, for example, has a glamorous provenance: it was donated by legendary film star Mary Pickford in memory of her parents, Charlotte and John Charles.

In this photograph from the ROM Archives, taken in June 1963, Mary Pickford is shown seated at a reception given in her honour at which she presented the embroidery to the Museum. Chatting with her are Winifred Needler, head of the Egyptian Department, and Harold M. Turner, chairman of both the ROM Board of Trustees and General Electric Canada.

The embroidery is worked on linen with coloured wools in a tent stitch. It depicts a tall vase on a pedestal base laden with fruit, sprays of acorns, and small flowers with birds perched on the lower sprays. The work is signed "Mary R 1943" near the lower right corner. The embroidery was made to raise money for charity by the grandmother of Queen Elizabeth II, Queen Mary, who was then Queen Mother. Queen Mary was well known for her work with charities, especially during WWII.

It is not known when or where Mary Pickford acquired the embroidery.

ARTHUR SMITH

Arthur Smith is librarian at the Royal Ontario Museum.

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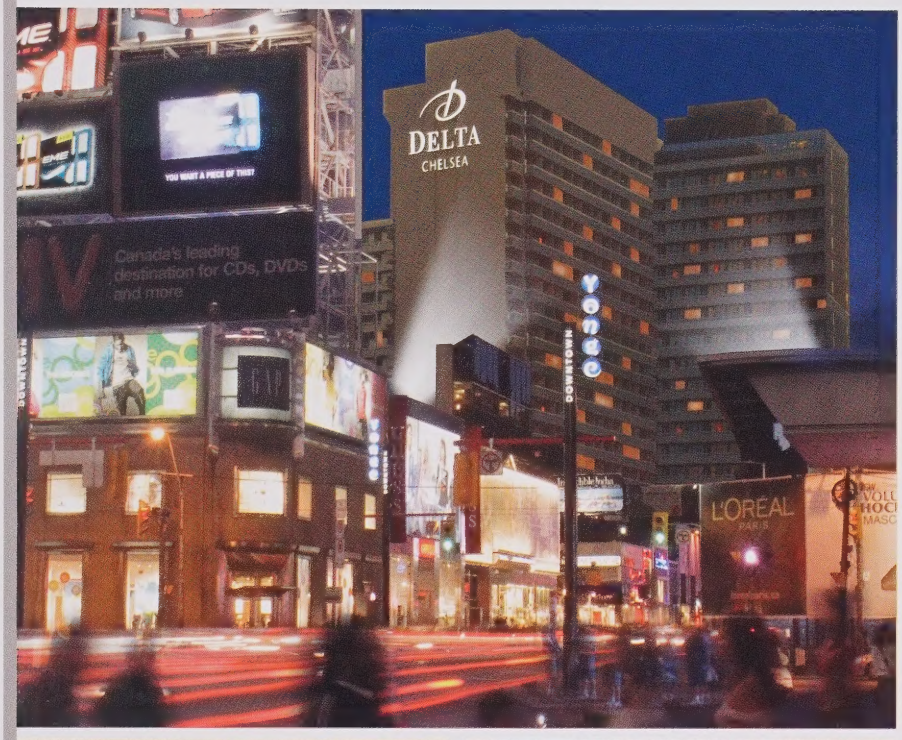

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